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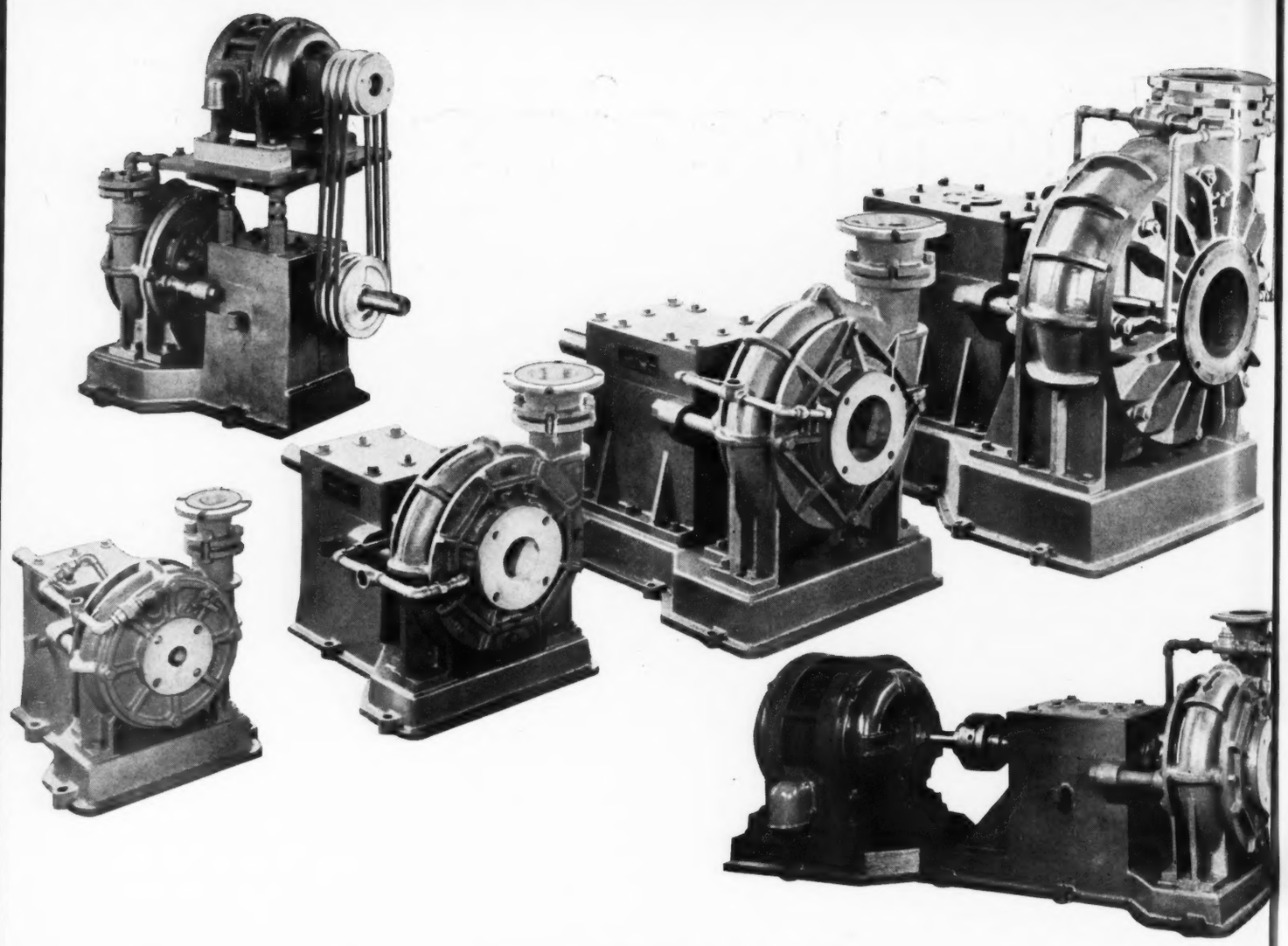
JUNE 1936

THE METALLIFEROUS ALTAI
MINING AT FRESNILLO
REMOVING HEAT BY VENTILATION
ARE AMERICAN EMPLOYERS INTERESTED IN THEIR EMPLOYEES?
THE BUBBLE MACHINE
DRILLING THE ROUND



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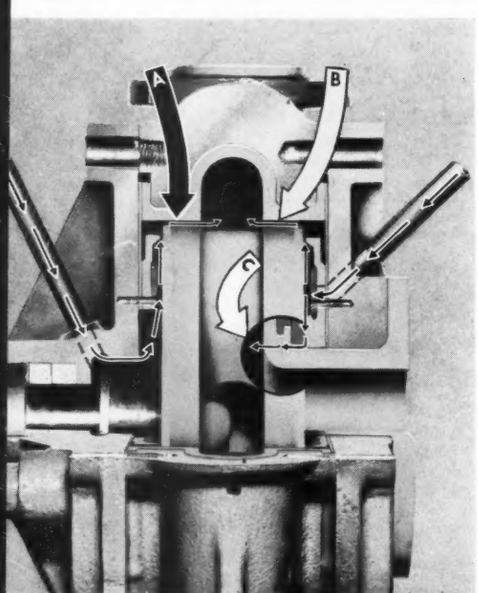

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Clarity in the Tax Bill. "If the dividend credit is a percentage of the adjusted net income which is more than 55 and less than 71 (and such percentage is not shown in the foregoing table) the tax shall be a percentage of the adjusted net income equal to the sum of 9, plus three-eighths of the amount by which 71 exceeds the percentage which the dividend credit is of the adjusted net income."

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First Hundred Years. The Geological Survey of Pennsylvania celebrated its centenary on June 12 and 13 at Harrisburg. Dr. George H. Ashley, State Geologist, was host to visiting scientists and arranged three field conferences for the study of geological formations in the Appalachians adjacent to Harrisburg. At a symposium on the mineral industry and the Geological Survey, representatives of the coal, oil, gas, and non-metallic mineral producers discussed the past and future services of the Survey to the State.

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CONTENTS
FOR JUNE 1936

Volume 137....Copyright 1936....Number 6

Editorial 273

The Metalliferous Altai of Soviet Russia. 275
Andrew Meyer and Edith Meyer

Mining Sulphide Ore at Fresnillo..... 279
J. H. Ashley

How Much Heat Is Removed From the Mine by the Ventilating Current?.. 285
Walter S. Weeks

Gold and Molybdenum From Mammoth, Ariz. 286
J. B. Huttl

Are American Employers Interested in Their Employees? 288
Analysis of a Survey

The Bubble Machine for Flotation Testing 291
Guido R. M. del Giudice

Drilling the Round 295
Reed E. Roberts

Weepah Gold 300
T. H. Oxnam

News of the Industry..... 304

Personal Items, Obituaries, Letters..... 316

Book Reviews 319

Equipment News 320

Summary of the Markets..... 322

"Keep Out!" signs in letters a foot high should be nailed over the entrance of all abandoned mines, prospects, or other holes in the ground that might invite investigation by the thoughtlessly adventurous. Trained mining men always proceed with caution. The tragedy at Moose River, which only yesterweek had the whole world by the ears, caused a coroner's jury to record observations that deserve wide publicity: "We would strongly recommend that mine owners, managers, and mining authorities use all vigilance in future, and see to it, before anyone is permitted to enter a gold-mine shaft, that it is reasonable and practically safe as far as human knowledge and expert ability can judge."

*

Green Balls of Fire, behind which crouched a mountain lion, confronted a now noted geologist when he sent the beam from his flashlight into a stope in an abandoned Western mine in the course of an examination made some years ago. The writing of the report on the property was postponed.

*

A Nugget of Gold 19 by 13 inches and from half an inch to five inches thick is reported by William Fraser Napier in *Northern Miner*. It was found at Ballerat, Australia, in the middle of the last century, by two brothers of the family. The mass weighed 146 pounds, and the task of getting it safely to Melbourne proved arduous. Finally the lucky pair obtained a wheelbarrow and trundled it for 75 miles, working at night and sleeping in the daytime. After exhibiting their find throughout the British Isles (at a fine salary paid by the Australian Government in its efforts to stimulate emigration), the nugget was deposited in the Bank of England. The discoverers returned to Australia to search for another, but the quest failed. There were optimists in those days!

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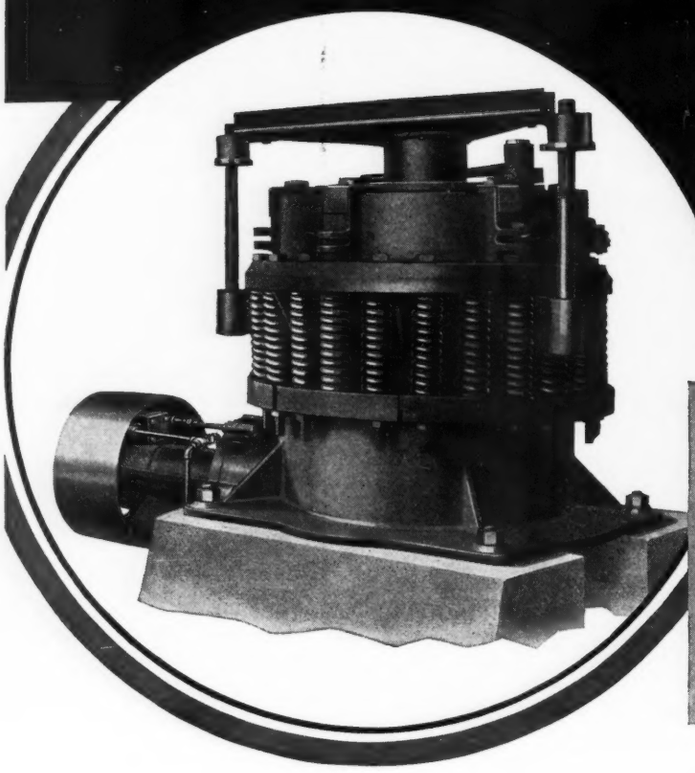

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Coal Control Unconstitutional

IN DECIDING against the constitutionality of the Guffey Act for the regulation and control of bituminous coal mining, the Supreme Court laid a number of ghosts with which our lawmakers have been attempting to frighten business. In the first place it is determined that mining is production, not interstate commerce. Second, wages, hours, working conditions, and collective bargaining in the mining industry relate to production, not commerce. Hence the Federal Government lacks power to control or regulate them under the commerce clause. Third, taxes may be levied for revenue, but not as a penalty to coerce business into alleged agreements. Fourth, Congress may aver, assert, or affirm certain facts and circumstances thought to justify its acts, but these remain opinions only and do not constitute enactment of law. Finally, "To a constitutional end many ways are open, but to an end not within the terms of the Constitution all ways are closed."

As enacted, the Guffey bill empowered the Federal Government to fix minimum prices for coal on the one hand, and wages and working conditions on the other. The majority of the Court found the latter an unconstitutional delegation of authority, and held that price fixing fell as an inseparable part of the act. A minority held price fixing valid but gave no opinion on wages and working conditions. Chief Justice Hughes alone passed on both phases, holding price fixing valid and wage regulation invalid.

Labor provisions of the act seemed particularly vicious. Under them the law of the land with respect to wages and hours in coal mining could be made by private interests. Operators producing two-thirds of the tonnage, and labor officials representing half the miners, could agree on hours of labor and impose their agreement on the whole industry. Likewise, district wages could be set by similar agreements. Minorities had no voice. The will of the majority practically became law through private negotiation. Such was the character of the bill about which the President expressed his hope to a member of the House that "your committee will not permit doubts as to the constitutionality, however reasonable, to block the suggested legislation."

We revert to an opinion, previously expressed in these columns, that this is not the way to bring about economic stability in the natural-resource industries, particularly the mineral industries. They differ from manufacturing industries in that their resources are exhaustible and not reproducible. They are particularly amenable to policies of conservation in the interest of the whole nation. It is on this basis—conservation of limited natural resources—and not on the fixing of prices, hours, and wages, that the Government can find reasonable justification for exercising some degree of control. The problem is to keep production in step with expected demand, to prevent gluts and famines with widely fluctuating prices to consuming industries. Somewhere in this realm lies the possibility of a fair agreement between Government and the mineral industries that will make for stability and conservation, allowing prices to find their own level in accordance with the forces of supply and demand, and leaving the adjustment of wages and hours to local negotiation.

It Didn't Make Sense

WHEN the Securities and Exchange Commission suspended the effectiveness of the registration statement of Franco Mining Corporation it spoke feelingly of the pseudo-scientific jargon used by self-styled engineers in describing the geology of ore deposits. Picture the Commission floundering about and trying to get a foothold in the morass of verbiage prepared by Franco's "engineer" for the edification and enlightenment of prospective stockholders. We quote: "Massive tufaceous andesitic and ryolitic [*sic*] of various thickness also form a part of the Devonian formation." Probably none will be more

surprised than the Devonian itself. Also this: "At or near the close of this period in which the gouge was erupted and before the volcanic action had entirely ceased its geyseritic and fumerolic [*sic*] formation, fissuring of this contact zone was formed." Well, perhaps.

In a spirit of outraged despair the Commission says, "It is difficult for us to find sense in these statements." Also it has something to say about the duties and obligations of an engineer who is employed to examine a mine and report thereon with the expectation that the funds of others will be invested in the project he endorses. Among other criteria, "His statement should be such that the layman may be able to appreciate the hazards of the undertaking and that the experts may be advised of facts from which the soundness of his observations and the conclusions drawn therefrom may be judged."

Of course, there were other things wrong with Franco's registration statement: vagueness about the interest of the promoters; the manner of distributing the stock; a deceptive balance sheet; glittering generalities about the value and quantity of ore; and the false results of a mill run. Average value of ore was determined by adding together fourteen assay values and dividing by fourteen. And it was alleged that thousands of tons of ore could be taken from the 290-foot shaft, despite the fact that it was filled with water to the 70-foot level. Such were the deficiencies of the registration statement. Probably no significance is to be attached to the fact that the property was on the slope of Jackass Hill. That would have been a belated ironic discovery by disillusioned stockholders.

Motors and Highways Supersede Railroads

SIGNIFICANT of the growing use of motor trucks in the mining industry is a recent action of the Interstate Commerce Commission. Examiners for that body recommended that the Colorado & Southern Railroad be permitted to abandon 185 miles of narrow-gage line in the vicinity of Leadville, one of the oldest mining districts in Colorado. Investigation had convinced the Commission's examiners that the mines in this area were making so much use of motor trucks that operation of the railroad was no longer profitable.

It is not difficult to sense the economic advantage to the mining industry of the combination of modern highways and motor transport. Ores, concentrates, machinery, and supplies can be handled with expedition and dispatch. Within economic limits of time and distance there is no necessity for trans-shipment. There is the obvious advantage of loading at the point of origin and delivery to final destination. In regions of heavy snowfall trucks and tractors can keep roads open throughout the winter and maintain communication between the isolated camp and the outside world.

Colorado is no exception in her extensive use of trucks in the mining industry, nor is the current instance the first case of the abandonment of railroads serving her mining districts. Good roads now ramify over the State to such an extent that it is possible easily to reach the principal mining centers by motor. In the changing economic development of transportation, motor trucks are rendering an indispensable service to the mining industry.

The Tax Muddle

STUPID TAXATION POLICIES have always inspired popular revolt. So it was not surprising that the Administration's proposal to lay a heavy tax on undistributed corporation profits brought a barrage of criticism from all branches of business and industry. The folly of the idea was quickly exposed. And in spite of Administration urgings the Senate could not withstand the vigor of the assault and refused to rubber-stamp the House bill to "equalize taxation." A new bill has been written, but it will have to be watched, because in spite of the Treasury's inability to offer impressive support for the original plan, the Administration will not lightly abandon its drive against corporation profits.

In the Senate hearings the mining industry was ably represented by A. G. Mackenzie, D. A. Callahan, and J. D. Conover. They spoke, respectively, for state mining organizations in Utah and in Idaho and for the American Mining Congress. Their presentations gave the Senate committee a liberal education in the characteristics of the mining industry: its inherent risks, the long and expensive process of developing a prospect into a mine, the necessity of building up cash as well as ore reserves, and the low ratio of successes to failures. Specific examples were cited showing the ruinous effects of the proposed taxation, not only in hampering some existing operations to the point of extinction, but certainly deterring the undertaking of new ventures. The arguments were valid and effective.

But still another matter disturbs the taxpayer, and that is the policy of the Bureau of Internal Revenue. Through that arm of the Government the Administration makes arbitrary interpretations of the law, goes after all it can get, refuses to compromise anything, and forces the taxpayer to pay or take the matter to court. Litigation is expensive, but large corporations incur the cost in the hope of winning. The small concern is more apt to pay and suffer injustice. The policy is vicious.

The Metalliferous Altai Of Soviet Russia

Andrew Meyer and Edith Meyer

Mining Engineer *Metallurgical Engineer*

Part I—GEOLOGY

Geological exploration of deposits along two tectonic zones discloses mineralization of unusual extent

THE ALTAI MOUNTAINS contain perhaps the oldest working mines within the huge territory of the Soviet Union. The Altai mines are certainly among the richest in the world.

About seventy-five different mines have operated in this region in the past, producing silver, gold, copper, tin, and lead. Some of these mines are operating today, and others are in a state of conservation. This article is mainly concerned with those mines which come within the system of the Altai Polymetal Combine, a subsidiary of the Non-Ferrous Trust of the U.S.S.R., and presents a brief history and general geology of the entire Altai mining region and a description of the mining, milling, and metallurgical practices of today.

Location

The Altai Mountains straddle the boundary line between the People's Republic of Mongolia and the U.S.S.R. The territory discussed in this artice is the southwestern section of the Altai Mountains and is inclosed by north latitudes 49 to 52 deg. and east longitudes 80 to 85 deg. All of the area is in the Irtysh watershed near its headwaters. The Irtysh is the greatest tributary of the Ob River and is one of the important waterways of the Soviet Union. It finds its source in Lake Zaisan near the Mongolian border.

Transportation in this region is afforded by the Ridder-Rubtzovska Railroad, which connects with the main trunk line of the Turkestan-Siberian railroad. From the beginning of May to the middle of October, river steamers and barges ply the river, and recently airplane service for mail and passengers was instituted.

The climate is similar to that of the Black Hills of South Dakota. The mountains are covered with forests, in which there is much game. In the spring myriads of flowers of every size and hue carpet the floor of the Altai valleys.

All of the mines now operating in the Altais are on ancient Chud workings. The Chuds were a little-known race, but some believe them to be of Aryan origin and others claim that they belonged to the Mongolian stock. They used bronze tools, and this fact testifies to their developed metallurgical skill. Their mines were well timbered and their workings reached a depth of a hundred feet. They worked the oxidized zones for tin, copper, gold, and silver. For some unknown reason the mines were abandoned, caved in, and were overgrown by the forest in the course of centuries.

In 1717 two Tomsk peasants, Koztilov and Komarov, brought the first reports of these old workings. This was during the rule of Peter the Great, who was much interested in developing metallurgical industries in the Russian Empire. He sent Saxon specialists to the Altais, and they confirmed the findings in 1722. By this time the metallurgical dynasty of the Demidovs had already gained a strong foothold in the Urals. During Peter's war with the Swedes, Nikita Demidov supplied cannon to the Russian army. In 1699 he organized the first iron works in the Urals with the help of state subsidies. Three years later Peter gave him this plant under the condition that he make only cannon and with the privilege of putting his serfs to work in his mills.

The son of Nikita, Akinfi, sent workers to the Altais, and they found copper on the sites of the ancient Chud workings. He transferred workers from the Urals to the new Altai works and settled immigrants about his mines and mills. He had more than four hundred households bound to him in serfdom. He cruelly exploited these serfs, and when they attempted to run away they were hunted by bloodhounds, and were chained to their barrows when caught.

Work began near Lake Kolivan in 1727, and in 1727 the first copper smelter was built on the shore of the River Loktivka. As more mines were opened, more smelters were necessary, and those of Kolivansk, Shulbinsk, and Barnaul were built. Because of the large amount of charcoal used, the smelters were built near the forests.

In 1747 the Altai mines became the property of the Tzar's Cabinet. The most productive mine of that period was in Zmeinogorsk, and from it large amounts of doré metal bullion was sent to the mint in St. Petersburg. At Suzunsk, in the Altai, a mint was erected for coining copper coins.

At this time no mining school existed in Russia, and cadets from the military school were sent to the Altais to study mining and metallurgy. One of these officers, Bolzunkov, made and operated a steam engine in 1766, or four years before Watt's steam engine became known.

In 1760 prizes ranging from one hundred to five hundred rubles were offered

Subsequent issues will cover the mining, milling, and smelting practice employed at the important base-metal mines in this region.

for the discovery of new mines. Exploring parties penetrated the mountains and reopened many of the ancient Chud workings. Thus, Ridder was rediscovered in 1784, Zyrianovsk in 1792, and Belousovsk in 1797. Toward the end of the eighteenth century mining in the Altais became widespread, and yearly production reached a maximum of 23,747 kilograms of silver.

Only the richest parts of the oxidized zones of the deposits were worked. The narrow, drift-like stopes were timbered and filled. Waste rock and low-grade ore encountered in the run of exploitation served as filling. Wheelbarrows and tote boxes were used for transporting ore and filling underground. The ore was hoisted by whims in leather buckets, but the miners had to descend and ascend on ladders. The mines were drained by Cornish pumps through wooden pipes made of hollow logs bound with iron hoops.

Liberation of the Russian serfs in 1862 proved to be the deathblow to the Cabinet-operated mines. Mining steadily declined from that time on, and in the beginning of the twentieth century a commission, appointed to investigate mining conditions in the Altais, stated that the mines could be operated only at great loss. By this time most of the oxidized ore was mined, and the sulphide ore proved to be too complex for the Russian metallurgists of those days.

Various attempts by French and English companies to exploit the Altai mines proved to be unsuccessful. The English carried on extensive exploration during and after the World War, but the Russian Revolution interfered with their plans. The mines became flooded and were not drained until they were opened under Soviet management only ten years ago.

For the sake of convenience, Soviet geologists divide the territory of the Altai Mountains into Greater and Metalliferous Altai. Greater Altai is understood to be that part of the Altai Mountains which is in the territory of the U.S.S.R., and Metalliferous Altai is used to designate only that part where metalliferous mineral deposits are known to exist, which covers an area of 40,000 square kilometers.

DIAMOND DRILL HOUSING

in Ridder. An extensive program during the last few years has determined the size of the deposits to be much greater than first believed

The territory of the Greater Altai is covered by greatly diversified rocks: sedimentary, intrusive, eruptive, and metamorphosed. The oldest rocks, Cambro-Silurian, are represented by metamorphosed series such as chloritized and epidotized argillaceous slates and tuffs.

In the Metalliferous Altai there are islands of metamorphosed rocks forming the cores of anticlines and covered over by Middle Devonian deposits. This fact suggests that the rocks composing the Metalliferous Altai are a part of that foundation upon which the younger Devonian and Carboniferous sediments of the Greater Altai are resting. The Metalliferous Altai is mainly composed of intensely folded and metamorphosed Cambrian and Silurian rocks along sharply defined tectonic lines, as clearly shown in the geological map of a section of the Altai Mountains, on page 277. Younger deposits played a lesser rôle and subsequent tectonic forces merely intensified the already existing deformations and metamorphoses.

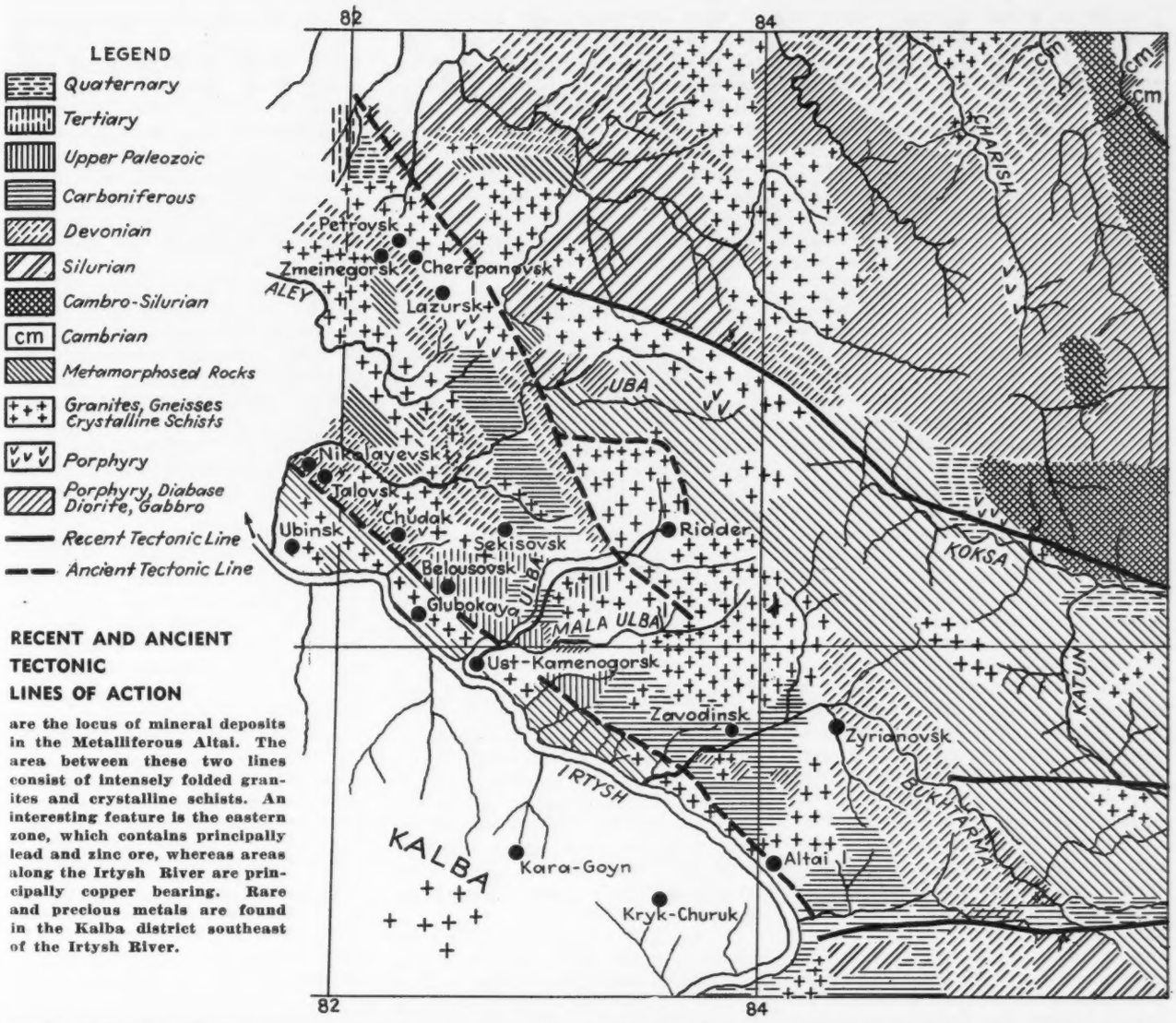
Several orogenetic movements contributed to the building up of the mountains of the Metalliferous Altai. The presence of Lower Paleozoic in the northwest definitely establishes two tectonic phases, one having taken place between the Lower and Upper Silurian, as in the Charish River Basin, and the other in the Lower Devonian, which caused the northeastern section to be elevated.

Because of the metamorphosed character of much of the sedimentary rocks of the Altai, fossils are not frequently encountered. However, there are certain characteristic fossils, such as the trilobites (*Megalaspis* and *Ampyx*), which are found in the valley of the

RIDDER

THE PRINCIPAL MINING CAMP IN THE ALTAI

accounts for a large increase in base-metal production in the Soviet Union. The Gregorovsky Shaft is not far from the town, and the new mill near-by on the extreme right affords sufficient light through its numerous windows. The Filipovka River meanders leisurely, dividing the community. The two black smokestacks in the center are part of the power plant



RECENT AND ANCIENT TECTONIC LINES OF ACTION

are the locus of mineral deposits in the Metalliferous Altai. The area between these two lines consist of intensely folded granites and crystalline schists. An interesting feature is the eastern zone, which contains principally lead and zinc ore, whereas areas along the Irtysh River are principally copper bearing. Rare and precious metals are found in the Kalba district southeast of the Irtysh River.

Charish in a bed of sandy slates of Lower Silurian a thousand meters thick. Separated from these slates by conglomerates is a series of Upper Silurian sediments made up of argillaceous slates with graptolites (*Monograptus priodon*) and limestone with Tabulata (*Halysites* and *Favosites*) and brachiopods (*Conchidium knighti*). Middle Devonian deposits are indicated by the presence of *Spirifer chicheli* in calcareous clayey slates in Southern Altai. In this same area evidence of the Upper Devonian is lacking—no fossils have been found.

There was an igneous phase in the Middle, or between the Middle and Upper Devonian, but its tectonic effects are little known. The tectonic phase which took place in the Middle Carboniferous is better understood. It folded the Devonian and the Carboniferous layers in the northwest, and in many places diorites or granodiorites intruded into these folds, causing intense changes in the rocks with which they came in contact.

At the end of the Paleozoic came a period of igneous activity. At first batholiths of granite were formed; then followed intrusions of quartz keratophyres. As the older rocks were interwoven with sills of diorite and granodiorite, they offered great resistance to folding, and the overlying strata were crushed and fissured rather than folded. Very long fissures were developed, some of them reaching a length of 500 kilometers. Thus the intrusives followed not only the folds but also the fissures of the crushed zones. It is probable that the great Kalba batholith, which runs parallel with the Irtysh tectonic line, acted as a buffer toward the Devonian and Carboniferous rocks of the Metalliferous Altai, saving them from intense folding. In Kalba even the Upper Paleozoic deposits are standing upright.

Mineralized Zones Defined

From an economic standpoint the most important tectonic phase is the one which occurred at the end of the Paleozoic, for with it are connected the intrusions of quartz keratophyres which carried the mineralizing solutions. Altai ore deposits belong between the Permian and Upper Carboniferous. The most important economic mineral deposits are found along two tectonic lines between which are included an intensely folded and crushed area. The places shown on the map, page 277, must be regarded as zones of mineralization rather than as single mines. In the neighborhood of each are several mines which were worked in the past, but at present some are inactive pending further exploration.

Along the Irtysh tectonic line lie the Belousovsk, Byrozovsky, and the Chudak mines; and along the eastern tectonic line the Zmeinogorsk, the Ridder, and the Zyrianovsk groups. Most of them are structurally similar, and many are connected genetically with quartz keratophyre intrusives. Interesting to note, however, is the fact that in the deeper and, therefore, hotter zones of the Irtysh group, copper is the predominant metal, whereas along the eastern tectonic line lead and zinc are predominant. In the neighboring Kalba field, where mineralized zones have still deeper origin, tin and tungsten, molybdenum, and gold are found.

Ore Genesis

There can be no doubt that the varied ore deposits of the Metalliferous Altai are in genetic connection with the igneous intrusions found in its territory. A glance at the geologic map of the Metalliferous Altai shows that about half of its area is occupied by granite. In the eastern section granitic outcrops are relatively few, but in the west there are huge granite massives which are connected evidently with the great batholith of Kalba, running parallel with the Irtysh zone of foldings. In this granitic zone there are many deposits of tin, tungsten, and molybdenum, such as those at Ubinsk, Kara-goyn, Kryk-Churuk, and others.

Though diabase dikes are found in granite a considerable distance from granitic masses, they are found only in polymetal deposits, usually intersecting the veins. In the Lazrusk deposit the dike is of the same age as the ore. Sometimes these dikes contain some crystals of metallic sulphides, but never enough to constitute ore.

N. A. Eliseyev suggests that the polymetallic deposits found their source in intrusives of plagioclase granite, such as at Zmeinogorsk, and that deposits of tin, tungsten, and molybdenum are connected with more alkali biotitic granite. On the other hand, V. P. Nehoroshoff claims that the varied character of the Altai deposits can be explained by the fact that those containing high-temperature, deep-zone metals were exposed by erosion on the flanks of the folded area; whereas those deposited within the folds in a cooler and higher zone were protected by rocks more resistant to erosion.

Field data show that the ore deposits of the Altai and Kalba are connected with intrusive orogenetic activities. Various intrusions of granite followed the folds, with accompanying dislocation and metamorphosis of the overlying strata. The roofs of the congealing and shrinking batholiths often cracked or caved in. Through these fissures and crushed zones later rose emanations carrying mineralizing solutions.

It is thought that from quiet, undisturbed intrusives were crystallized out cassiterite, wolframite, molybdenite, and beryl. The gold deposits of Kalba are connected with the granitic intrusions which were injected into the crushed roofs of the batholiths.

Porphyritic intrusions rising and congealing a great distance above the granitic mass released the acidic solutions which formed the polymetallic deposits of the Altai. They are mostly metasomatic of complex form, composed of solid sulphides and strongly metamorphosed wall rocks impregnated with metallic sulphides. Gash veins are relatively rare (Cherepanovsk and Chudak) and evidently were formed by local manifestations of tectonic and igneous activity.

Metasomatic processes are characterized by sharply defined zones of metamorphosed wall rocks composed partly of highly siliceous hornstone, locally known as "rogovik," and of chloritized and sericitized slates. Deposits follow the folds of the country rock, and often have anticlinal or dome shapes. The upper section of the deposits is often eroded and covered by a capping of alluvia.

The Altai polymetal deposits are mesothermal in character, having been deposited by circulating hydrothermal waters. They contain zinc, lead, copper, cadmium, iron, gold, and silver, and a number of rare elements in small quantities, such as vanadium, arsenic, tellurium, bismuth, titanium, and gallium. Distribution of the metals in the ore varies in the different deposits. The minerals usually occurring are galena, sphalerite, chalcocite, chalcopyrite, tetrahedrite, and pyrite, and infrequently arsenopyrite and pyrrhotite are found. Very rarely the tellurides hessite and altaite occur, as in the Savodinsk mine. Gold is found in three forms: free, and often in coarse nuggets; alloyed with silver, electrum; and as telluride. The gangue minerals are quartz, barite, carbonates, sericite, and chlorite.

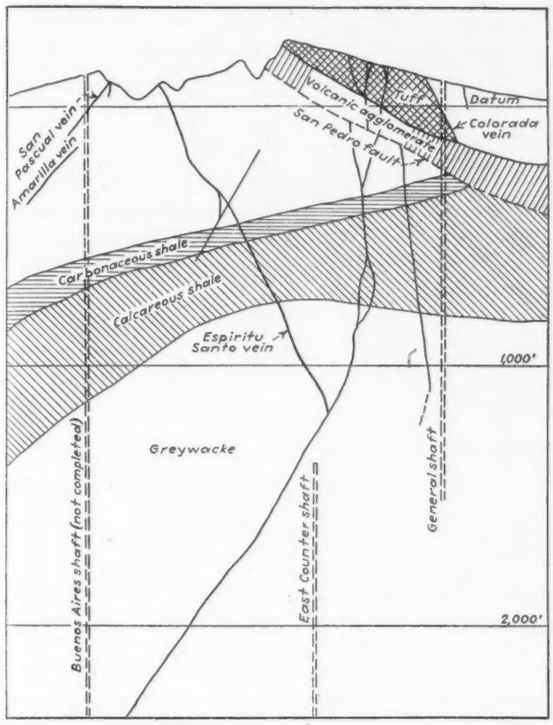
Deposits Are Epithermal

In the different deposits various minerals are found which give indications as to the temperatures at which the several deposits were formed. Thus at Sekisovsk, where the deposit is believed to be epithermal, kaolinite predominates, but there is some alunite as well. Tellurium compounds of lead and silver were found in the Zavodinsk mine and in the Talovsk mine. Such high-temperature minerals were found as pyrrhotite, cubanite, hematite, and magnetite. Hematite is known to exist in the Nikolayevsk mine also.

Following the ore deposition there was an igneous activity indicated by diabase dikes in Zmeinogorsk, Petrovsk, and Cherepanovsk.

Depth of oxidation is usually between 30 and 60 meters. Oxidation enriched the oxidized zone with gold and silver but caused the loss of much zinc. Secondary enrichment is not very important in most of the deposits, but is indicated by the presence of covellite, chalcocite, and argentite. Microscopic examination shows that Altai ores are very fine grained.

Mining Sulphide Ore At Fresnillo



IDEALIZED GEOLOGICAL CROSS-SECTION

of Fresnillo mine. At depths of 400 ft. below the summit of the Proaño Hill the economic mineralization is confined to a large number of veins of varying widths and importance. Sulphide mineralization also appears at this horizon, although in exceptional cases oxide ore, so abundant near the surface, is found for 350 ft. or more below this depth. Fracturing is intense in the upper 500 ft. of the deposit. Below this zone it is infrequent but persistent

Underhand open stoping is found to be best suited to conditions, taking the Mexican miners' previous training also into consideration

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SEVEN HUNDRED and fifty miles south of El Paso, at Fresnillo, in the State of Zacatecas, Mexico, is the Fresnillo mine of the Mexican Corporation, which operates the property through a subsidiary, the Fresnillo Company. Brief reference was made to the mining and milling work of this enterprise in the March number of *Engineering and Mining Journal*. Still earlier articles have gone into great detail. One, written by T. C. Baker, general manager of the Fresnillo Company and published in *E.&M.J.* of Dec. 1, 1923, discussed the methods used in extracting the surface ores by glory-holing. That paper was subsequently supplemented by an article written by A. Livingston, late mine superintendent, and published by the United States Bureau of Mines in 1932 as its Information Circular 6661, wherein was described in detail the mining of the oxide ores by not only the glory-hole method but the other methods also used. The Fresnillo mine produces sulphide ores as well, and it is the mining of these, together with certain related operations, that provides the subject of the present paper.

Practically the entire output of the mine up until 1926 came from the large silver-bearing oxidized orebodies which comprise Proaño Hill. Since 1927 the veins of primary sulphide ore which are found beneath the oxidized zone have been developed and mined extensively.

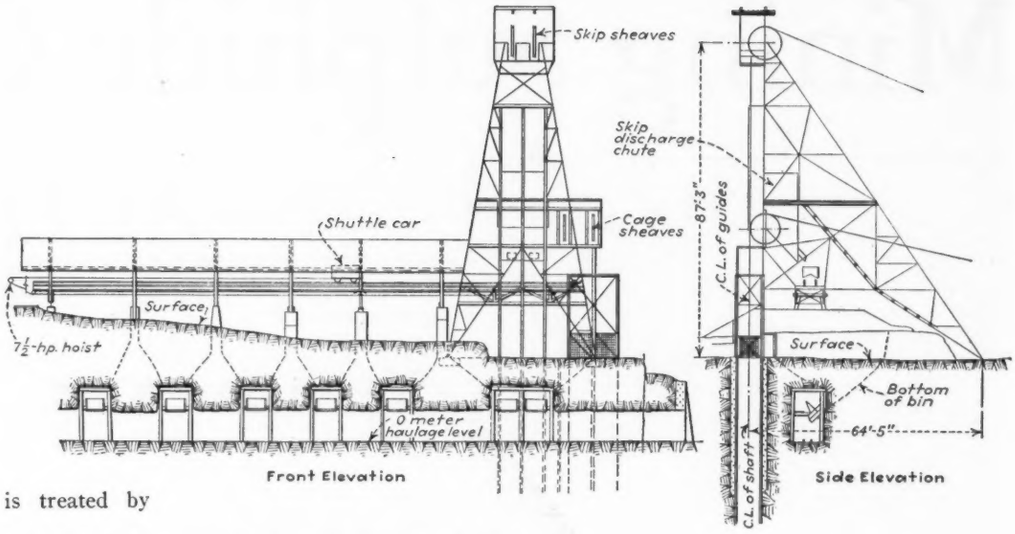
Mining operations are centralized in Proaño Hill, in a highly fractured and mineralized area. Near the surface the action was intensive enough to form a silver-bearing orebody from which over 12,000,000 tons of ore has been mined, averaging 5.6 oz. of silver per ton. At depths of 400 ft. below the summit of the hill the economic mineralization is confined to a large number of veins of varying widths and importance. Sulphide mineralization also appears at this horizon, although, in exceptional cases, oxide ore is found for 350 ft. or more below this depth. The graywacke, calcareous shale, and carbonaceous shale found near the surface continue to the lowest depths yet reached by mine workings, but the intense fracturing is confined to the upper 500 ft. of the deposit. Below this depth fractures are infrequent but persistent; faulting is rare and the displacement slight.

Mining operations were begun by the Spaniards, who are credited with the discovery of the Fresnillo mines in 1570, and continued in an intermittent manner until 1835, when control of the mines came into the hands of an English company. This company was forced to cease operations in 1867, due to political disturbances occasioned by the French occupation of Mexico, and the mines lay idle, except for pillar-robbing above the water level and sorting of ore dumps, until 1903, when the Fresnillo Mining Company erected a tailings-treatment plant. In 1911 a 500-ton cyanide plant was built to treat ore from dumps and from open cuts on Proaño Hill. The revolution in 1913 caused suspension of operations until 1919, at which time the Mexican Corporation obtained a long-term lease on the property and constructed a 2,200-ton cyanide plant, the capacity being later increased to 3,000 tons.

Discovery of pieces of sulphide ore in the surface dumps suggested the existence of veins of primary sulphide beneath the zone of oxidation, and in 1925 a vein (the Cueva Santa) of complex silver-lead-zinc-copper ore was found on the 345-ft. level. Further exploration led to the discovery of a sufficient quantity of ore to justify the construction of a small mill, which was subsequently increased by stages to its present capacity of 1,300 tons per day.

Ore Types—Three classes of ore are mined at Fresnillo; namely, oxide, light sulphide, and heavy sulphide. The oxide ore, valuable chiefly for its silver content (the gold to silver ratio by weight is 1.5 to 1,000), occurs from the surface to the 540-ft. level. (The datum plane from which mine levels are numbered is 320 ft. below the summit of Proaño Hill.) Principal minerals present are sulphides of silver, oxides of iron and manganese, quartz, and calcite. At this property the country rock is typically oxidized and shattered, and varies from a calcareous to a carbonaceous shale, graywacke, and a volcanic

[1]The Cia. Dos Carlos is under the same management as the Fresnillo Company. At the time the preparation of this article was undertaken, Mr. Ashley was on the staff of the latter company as assistant mine superintendent. He assumed his present position on Jan. 1, 1936.



GENERAL SHAFT HEADFRAME

and ore-bin arrangement at the Fresnillo mine. The shaft is 1,475 ft. deep and is one of two working shafts sunk from surface on the property. A third shaft, the Buenos Aires, is in course of sinking. The property also has an interior shaft that extends from the 1,395 level to the 2,280 level

agglomerate. The ore is treated by cyanidation.

The light sulphide ore is found in narrow veins and in mineralized shale beds. Average ore contains 0.03 oz. gold and 16.5 oz. silver per ton, 1.5 per cent lead, and 1.5 per cent zinc. Mill treatment consists in bulk flotation in which all the sulphide minerals are floated in one operation with no separation into lead or zinc concentrates, followed by cyanidation of the tailings from the flotation machines.

The heavy sulphide ore exists below the 345-ft. level, in formal veins varying in dip from vertical to 50 deg., and striking in a generally northwest direction. Vein minerals are pyrite, chalcopyrite, argentiferous galena, sphalerite, marmatite, quartz, and calcite. The wall rocks are principally calcareous shale and graywacke. Typical ore assays 0.02 oz. gold and 10.7 oz. silver per ton, 7.9 per cent lead, 8.3 per cent zinc, 7.6 per cent iron, and 0.71 per cent copper. Seventy-five per cent of the heavy sulphide ore mined has come from the Cueva Santa vein, in which the oreshoot has a developed vertical extent of 1,900 ft. and a maximum horizontal extent on the 1,115-ft. level of 3,300 ft. The heavy sulphide ore is treated by selective flotation, the products being concentrates of lead, zinc, copper, and iron sulphides.

Exploration and Development—The sulphide section of the mine is served by two surface shafts, the General shaft and the Saraos, 1,475 and 1,925 ft. deep, respectively. These were sunk to a considerable depth before the Cueva Santa vein was found, and they are not advantageously located with respect to it. To eliminate the long crosscuts that would be needed on the lower levels, an interior shaft was sunk from the 1,395-ft. level to the 2,280-ft. level.

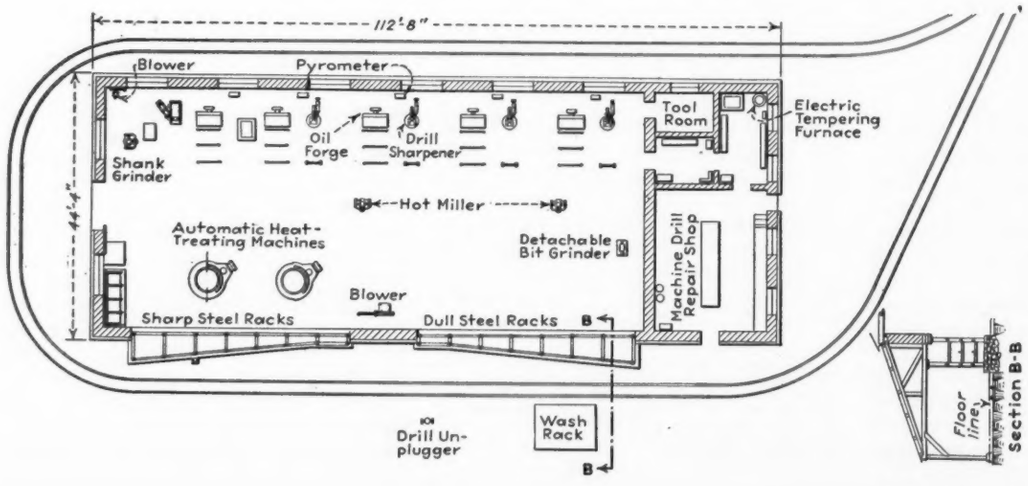
To improve ventilation, decrease time lost in lowering and hoisting men, permit removal of long sections of track and pipe, eliminate maintenance of many levels, and allow recovery of floor and back pillars on partly worked-out levels, a new shaft, the Buenos Aires, is being sunk from the surface 3,000 ft. west of the interior shaft. The Cueva Santa vein will be intersected 2,650 ft. below the surface.

Diamond Drilling—This has been very useful in locating veins paralleling existing workings, in exploration, and in directing development work. Several previously unknown veins have been found in this manner.

About 1,000 ft. of diamond drilling is done per month, consisting principally of holes having a depth of 400 ft. or less. Two Mitchell compressed-air light-weight machines are used in this work. Cores are examined and classified by the geologist; when advisable the core is split and half is sent to the laboratory for assaying.

Mining Method—At the time of the discovery of the sulphide ore, the greater part of the mine production was from the glory holes. The miners were well trained in the use of the jackhammer type of drill, and nearly all equipment was of this type. Wall rock in the sulphide mine requires little support either during or after extraction of the ore, and inasmuch as the veins are but 3 to 5 ft. wide, such support as is necessary is easily furnished by small pillars of ore and waste, or by timber.

Shrinkage stoping would be difficult in such narrow orebodies, due to the possibility of the broken ore hanging up and endangering the men working above. It would have been necessary to train the men to work a system very different from the glory-hole method,



AN UP-TO-DATE DRILL SHARPENING SHOP,

shown here in floor layout, is provided at the Fresnillo mine. In it is sharpened and hot-milled the drill steel used underground. In addition, detachable bits, also employed, are reground, and the rods used with them re-threaded

Table I—Cost of Sinking the Interior Shaft

(Sinking only, exclusive of stations, pockets, and cable raise)	Cost per Foot
Labor and supervision	$38.87
Explosives (25.1 lb. per foot)	5.15
Steel sets (material and labor in fabrication) and guides	15.05
Drill repairs	0.13
Steel sharpening	0.71
Compressed air	1.59
Power	1.58
Miscellaneous materials (cost of machines, drill steel, drilling supplies, etc.)	9.28
Total	$72.36

Table II—Diamond Drilling Costs

	Cost per Foot Drilled
Labor and supervision	$0.33
Carbons	0.34
Setting	0.03
Supplies and miscellaneous	0.15
Total direct cost	$0.85

Table III—Tonnage Developed Per Foot of Advance, July 1, 1932, to July 1, 1935

	Tons Ore Developed per Foot Advance	Feet Advance per 1,000 Tons Developed
Development winzes and raises	73	14
Development drifts and crosscuts	52	19
Stope preparation (a)	62	16
Total	20	49

(a) Stope preparation here includes stope preparation, drifts and manway raises, intermediate raises, and drifting, winzing, and raising in the stopes in order to leave pillars.

Table IV—Cost of Sharpening Regular Steel

	Cost per Steel Used, Cents U. S. Currency
Labor and supervision	1.5
Fuel and supplies	0.7
Repairs	0.2
Compressed air	0.1
Steel loss, including steel lost in the mine	1.6
Delivery to the underground tool rooms, distribution and delivery to the working place	3.2
Total direct cost	7.3

Table V—Mining Costs, Sulphide Ore

	U. S. Dollars per Short Ton
Development	$0.43
Ore breaking, including preparation and stoping	0.50
Haulage and hoisting	0.13
Drainage	0.05
Other mining expenses (compressed air, steel sharpening, drill repairs)	0.67
Total	$1.78
Labor and supervision	0.96
Supplies	0.64
Power	0.16
Miscellaneous	0.02
Total	$1.79

Table VI—Distribution of Labor

Oxide and Sulphide Ore Mining Combined

	Per Cent Total Labor
Development	23.1
Ore breaking, including preparation and stoping	38.8
Haulage and hoisting	10.2
Other mining expenses	27.9
Total	100.0

Table VII—Power Consumption

Per Ton Ore Mined (Oxide and Sulphide Combined)

	Kw.-Hr
Pumping	4.1
Hoisting, including man hoists	2.1
Compressors	9.3
Other uses	1.4
Total	16.9

and to use a different type of drilling machine. Maintenance of timbered manways through the broken ore in the stope would have been necessary for ventilation, and the cost thereof would be an item of some consideration charged against the tonnage served by each manway.

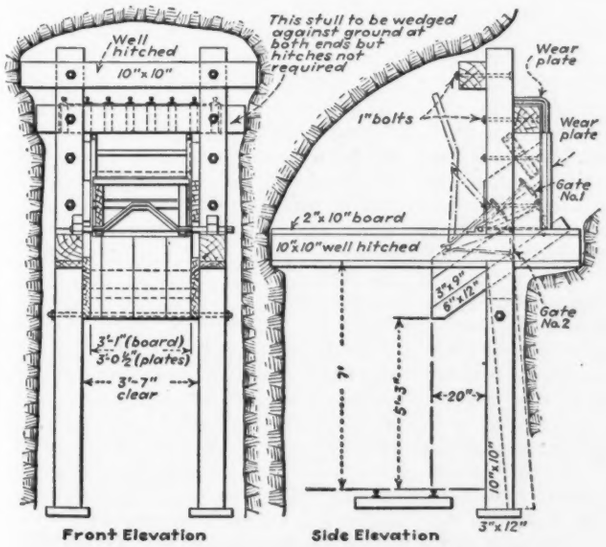
Another condition which has become of more importance in the deeper parts of the mine, and especially where the copper content of the ore is high, is that broken ore allowed to remain in the stopes for long periods, such as would have been the condition had shrinkage stoping been adopted, oxidizes to an extent which lowers mill recovery.

Consideration of these factors influenced C. E. Prior, then mine superintendent, to select the open-stope underhand system of mining. Experience has justified the choice, although some modifications of the original method have been evolved, the principal change being the mining by overhand stoping of the payable stretches over the haulage level, as will be described later.

In mining 1,750,000 tons of ore, less than 1 per cent of the tonnage has been left as pillars, and many of these will eventually be recovered. Expressed differently, the ore contained in pillars when the ore reserve estimate was made in 1935 was 1.75 per cent of the total amount of proved ore on that date. Twenty per cent of the stoped area has been waste-filled, both for wall support and for cheap disposal of waste rock from development work. These features are of interest because strong walls are a prime requisite for the successfull application of the method described.

Haulage levels are driven at 445-ft. intervals, with two sublevels spaced equally between. Vertical connections between levels and sublevels are made 220 ft. apart, unless such spacing would cause them to come into unpayable parts of the vein.

The vein above the haulage level is extracted by overhand stoping to a

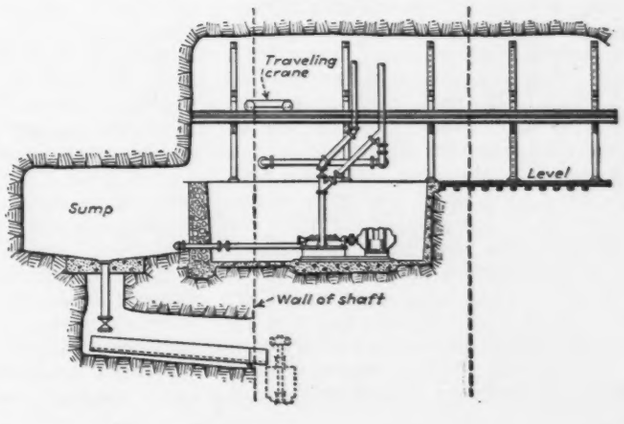


STANDARD CHUTE FOR SULPHIDE ORE

in the Fresnillo mine. There is but one gate, which may be placed in either one of two positions (shown here as Gate 1 and Gate 2) to give the best operation

SUMP AND PUMP ARRANGEMENT

as proposed for the East Counter shaft station on the 2,280-ft. (695-meter) level of the Fresnillo mine. To facilitate the removal of the mud that may settle in the sump, the raise shown was driven from the skip compartment of the shaft to the bottom of the sump. In this raise was cemented a 6-in. pipe having a valve at the shaft.



HACIENDA PROAÑO

of the Fresnillo Company, as seen from the summit of Proaño Hill close to the edge of the huge glory hole. Within the walls of the Hacienda are the company's power plant, offices, and the manager's residence. To the immediate left of the power plant may be seen two masonry towers housing the remains of the Cornish engines that worked the arrastres used for grinding the ore in the middle of the last century, for subsequent treatment by the patio process within the same inclosure. At the right of the picture is the building that formerly housed a School of Mines. The remnant of an old aqueduct is seen in the foreground. In the upper left corner is part of the Mexican town of Fresnillo. The company's mills lie to the right outside the picture

height of 25 ft. above the track level, leaving no pillars of ore. The level is then protected by round stulls hitched into the walls 10 ft. above the rail and covered over with round poles 6 in. in diameter. Should the length of the stulls exceed 10 ft., vertical posts are placed under them to increase their strength. Chutes are built at 40-ft. intervals if the dip of the vein is 50 deg. or flatter, and at 50-ft. intervals where the inclination is steeper. Overhand stoping then proceeds to a height halfway to the first sublevel. No formal manways are required; the men enter convenient chutes and climb up the flat slopes of broken rock to the relatively low heights gained by the stope.

The advantage of overhand-stoping the section immediately above the haulage level may be mentioned at this time, before continuing with the description of underhand stoping methods. A large storage space for broken ore is provided; better ventilation for subsequent operations is accomplished; and no pillars of ore remain to be recovered later when conditions are less favorable for economical mining. The amount of shoveling in the underhand stopes is reduced, thus allowing a greater part of the men's time to be devoted to drilling, with a resultant improvement in the output per man.

Ore remaining above the overhand stope is extracted by underhand stoping, each sublevel serving as a point of attack. Stope-preparation drifts are driven beneath each level, leaving a pillar 6 ft. thick to maintain the level above. These drifts are started from the ore passes between levels and driven until they are connected with the next pass, or to the limits of the oreshoots if the payable ore does extend the full distance. At midway, or in the alternate case at the limit of the ore, a small raise is driven to the level above to provide easy access to the working slope of the underhand stope.

Underhand stoping begins at the point of departure of the preparation drift from the ore pass. The stope is worked in benches, each long enough to be completely drilled in one shift with one machine (ten to twelve 6-ft. holes). Two machines work in each stope, requiring a total of two machine men and one steel nipper per shift. Each crew mucks off the broken rock left on the benches by the blasting of the preceding shift, blows off all the fine rock with blowpipes so as to uncover any missed holes, drills the round (two benches), and blasts, so that each shift completes a full cycle of operations. Safety inspectors visit each stope after the benches have been cleaned and blown off, and examine them carefully for missed holes, which are blasted before any drilling is done.

Barren parts of the vein are left as pillars, and where the condition of the walls requires it, pillars of ore are left for support. As little timber as possible is used, inasmuch as stulls are easily broken by blasting; also, inspection of timber is difficult, because it becomes inaccessible in time. Masonry pillars have been used to some extent; they possess the advantage of permanence and do not leave ore to be recovered or lost.

Wooden ladders, resting on light stulls, are kept in place down to the next bench above the ones being drilled. Below the last ladder, ascent and descent are by means of ropes. Cable ladders placed below the wooden ladders have been tried, but are not entirely satisfactory. In wide stopes the ladders are sometimes hung from short pieces of steel rod placed in drill holes in the footwall of the vein. Under such conditions ropes are left hanging alongside the ladders as an aid to climbing.

Drifting machines are used in overhand stoping; jackhammers weighing 75 lb. are employed in underhand stopes. Each type of machine uses 1¼-in. hollow-round lug steel. Lubrication is effected by means of a sight-feed drip line-oiler, placed on the air line near the hose connections.

All stoping is done by contract on a cubic-meter basis. In stopes in which the vein is less than 3 ft. wide, payment is made on the area of stoping done, measured in the plane of the vein, thus making it to the advantage of the contractor to keep the stope narrow, thereby avoiding unnecessary dilution of the ore.

Each month the grade of ore which should be produced according to the ore-reserve calculations is compared with the actual grade attained. This procedure furnishes a close check on the estimates or serves to call attention to waste dilution in the event of overbreakage. Over a period of months it also provides a new experience factor for guidance in future calculations.

Tons broken per man-shift in stoping are as follows: Underhand stoping, 3.1; overhand stoping, 3.3; ore breaking, including all stoping and preparation work, 2.2. The favorable comparative showing of overhand stoping is due to the fact that the working face is not carried to limits that are difficult to reach.

Drifts are driven with machine drills of 4-in. cylinder diameter, mounted either on vertical columns with arms or on horizontal columns. Contract prices range from $3 to $8 (United States currency) per foot, varying with the size of the drift, the working conditions, and the importance of the work.

Raises are driven 5x7 ft. in cross-section, on a 55-deg. slope, with the same type of drifting machines as is used for drifting. No timbering other than that used in building the chute is

employed. Raising on a 55-deg. slope has been found to result in fewer accidents, more speed, and lower cost than raising on a steeper angle. Contract prices range from $3 to $6 (United States currency) per foot.

Electric-powered, single-drum, 7½-hp. hoists are used in sinking winzes, with sinking buckets of 5½- to 9-cu.ft. capacity, and ⅝-in. diameter stranded cable. In inclined winzes the buckets slide on 4x6-in. skids laid on sills. The hoisting compartment is 4x5 ft. in horizontal section and is lined off from the manway compartment, 3x5 ft. in size, with 1-in. plank. Drilling is accomplished with jackhammers of the same type as used in stoping.

A large proportion of vertical development is done by winzing because it obviates the necessity of long raises, connections can be made more quickly, information as to the ore beneath the lowest level can be obtained quickly without the necessity of waiting for shafts to be sunk, ventilation is better than in raises, and the cost of winzing is very little above the cost of raising. Here again, the familiarity of miners with jackhammers and lack of skilled timbermen are factors, making winzing instead of raising more important in vertical development. Contract prices range from $5 to $7 (United States currency) per foot in small winzes to a depth not exceeding 150 ft.

Tonnage of ore developed per foot of advance in the period July 1, 1932, to July 1, 1935, is given in Table III.

In a typical section of an oreshoot. the ore removed is mined as follows: Development and preparation, 13 per cent; stoping, 80 per cent; left in pillars (most of which is recovered later), 7 per cent. Total, 100 per cent.

Hoisting—An average of 780 tons per day is hoisted in the Saraos shaft, which is equipped with 3-ton capacity skips, hoisted in balance. The hoist is of Wellman-Seaver-Morgan manufacture, using a 350-hp. motor and the Ward Leonard control system. The maximum hoisting speed is 700 ft. per minute.

All men are lowered through the General shaft, in which a cage holding 50 men is operated. The cage is made of aluminum with the exception of the safety dogs, and weighs 5,000 lb. complete, replacing the steel cage formerly in service, which weighed 8,500 lb. This reduction in weight made possible an increase in hoisting speed of 200 ft. per minute, with no change in the hoist or motor other than the substitution of a pinion gear of larger diameter. At the same time the cable safety factor was increased.

Underground Haulage — Tracks on haulage levels are laid with 40-lb. rail, using ties 3 ft. 6 in. long with a 5x7-in. cross-section. On sublevels either 16-lb. or 25-lb. rail is used, depending upon how much ore is expected to be trammed over that particular section. Ties made of 5-in. diameter round poles, trimmed on the top and bottom by hand with axes to provide a bearing surface for the rail, are used for sublevel tracks.

Two 4-ton storage-battery locomotives, carrying 84 Edison storage-battery cells each, and three 1½-ton locomotives, each carrying 40 cells, are used for underground sulphide ore haulage. The 4-ton locomotives each pull trains of ten 33-cu.ft. rocker-dump cars. The smaller locomotives haul either 33-cu.ft. cars or smaller cars of the Matteson type.

Ore from the shaft bins on the surface is conveyed to the crusher plant in trains of five 275-cu.ft. cars, each train being pulled by an 8-ton trolley locomotive.

Ventilation—The General shaft and the Saraos shaft are operated downcast by one Jeffrey Multivane fan placed at each of them, on the 1,395- and the 1,840-ft. levels respectively. Each fan is belt-driven with a 50-hp. motor, and delivers 75,000 cu.ft. per minute against a 2½-in. water-gage pressure. The air is delivered to the bottom levels, and passes upcast through the stopes and ventilation raises driven for the purpose. Air currents are controlled by a system of doors and brattices.

Coppus 5-hp. electric Ventair fans are used for ventilating headings, supplying air through 16-in. diameter galvanized-iron pipe made in the company shops from cyanide cans. One 50-ft. length of flexible tubing is used at the face of each drift. The coupling design now in use has proved satisfactory in eliminating leakage in ventilation pipe joints, and has supplanted former designs using gaskets.

A ventilation raise is driven parallel to each ore pass to a height of 50 ft. above the level, and connected to the ore pass by a drift, thus leaving a storage space for ore in the ore pass, above which the air current can move freely. The ventilation raise also gives better working conditions while driving the ore pass, and can later be used in stoping operations.

Pumping — The principal pumping station is on the 1,305-ft. level, from which all the water from the mine, varying with the season from 550 to 650 g.p.m., is pumped, through two 8-in. pump columns, to storage tanks on the surface. One Cameron five-stage, 600-g.p.m. pump, equipped with a 400-hp. motor, and one six-stage Cameron pump of 1,000-g.p.m. capacity, equipped

with a 550-hp. motor, are installed on this station.

Two 1,000-g.p.m. pumps are placed on the 1,840-ft. level, pumping through the East Counter shaft to the 1,395-ft. level.

On the 2,280-ft. level two pumps are to be placed, each having a capacity of 1,000 g.p.m. This installation, which is illustrated in one of the accompanying cuts, will differ from the others in that the operating pump is to be located at an elevation lower than the surface of the water in the storage sump, so that the water input to the pump will be under pressure. Easier starting and more efficient operation are expected to result. A standby pump will be placed on the station level, so that in an emergency the whole level can be flooded up to the height of the pump without stopping its operation.

The floor of the storage sump is connected to the shaft by a short raise in which has been cemented a 6-in. pipe with valve. Accumulated mud can be drawn through the pipe into the skips, hoisted, and disposed of in the stope fills.

An Up-to-date Shop

Steel-Sharpening Shop — The dull steel is unloaded onto a washing table, where mud and dirt are removed by washing with a hose. Then it is sorted into racks according to length and type of steel. Three types are in use—1-in. hollow-round lug, 1¼-in. hollow-round lug, and ⅞-in. hollow-hexagon collared. Plugged steel is unplugged by use of a drill-steel unplugger manufactured by the Pan-American Engineering Corporation. About 15 per cent of the plugged steel cannot be opened by this means and must be either cut off or drilled out by other means. Most of such steel has been stopped up by pieces of wood or metal.

Five steel sharpeners are in use, one of them for shanking and bitting new steel. Each pair of the other four sharpeners works in conjunction with a two-wheel Morgan hot-miller. Alone, each sharpener has a capacity of 300 to 350 steel per shift; used with the hot-miller, its capacity is raised to 450 to 500 steel per shift. The steel is heated in Worthington gas-oil furnaces, with the fuel-air mixture automatically controlled by pyrometers.

The sharpened steel is conveyed in rubber-tired trucks to two Gilman tempering machines, also pyrometer-controlled, which bring the steel to the proper temperature and quench the heated steel automatically. The tempered steel is stored in racks, from which it is taken to the mine as needed.

Drill-steel shanks are tested for size by inserting them into a standard machine-drill chuck, and the ends are squared up in a shank-grinding machine.

Thorough tests on detachable bits have been made, and it has been found that they can be used advantageously in working places into which it is difficult to transport steel. They are used exclusively at all of the company's smaller mines, because of the less satisfactory results that would be obtained with regular steel under the ordinary supervision and with the limited equipment permissible in steel-sharpening shops at such properties. The shop is equipped with a Toledo threader, which threads rods for the detachable bits used at all the mines of the Fresnillo Company within a radius of 100 miles. A bit-grinding machine is provided for bits used locally. Approximately 350 detachable bits are dulled daily in the Fresnillo mine, and 3,200 ordinary steel are used in the same period.

Promising experiments are being conducted on reforging worn-out detachable bits. In this process, bits which have been worn down to a point where the bit diameter is no greater than the skirt diameter are upset in an ordinary sharpening machine, using special dies which prevent distorting of the thread section. The bits are then retempered, ground slightly to improve their shape, and are ready for use. Grinding is necessary, as a long period of shaping in the sharpener tends to distort the bit threads. Results to date indicate an average of two extra usages for reforged bits. Some badly worn bits may break when used after upsetting, due to the small volume of metal remaining in the body of the bit.

Average output for the entire shop (exclusive of the detachable bits), including shanking, bitting, sharpening, tempering, and repair of sharpening machines, is 75 steels per man-shift. The cost per steel, including all items other than depreciation on equipment, is given in Table IV.

A machine-drill repair shop is maintained in conjunction with the steel-sharpening shop. All repairs are made in the shop. A strict rule is enforced against dismantling of the machines underground, other than for replacement of water needles. Record is kept of repair parts placed in each machine.

Chucks, chuck bushings, front-head bushing, and similar parts are made in the company shops, tempered in a Leeds-Northrup electric "hump" furnace, and checked for hardness with a Rockwell hardness tester. Such parts compare well with purchased parts and represent a considerable saving.

Most Workmen on Contract

Wage and Contract System—Of the sixteen hundred men employed in the mining department, including those in the blacksmith and steel-sharpening shops, the mine mechanics, the timekeepers, and those in the engineering and sampling department, two-thirds work on contract. Pipe and track work, motor tramming, and a part of the timbering is done on company time.

Contracts on development work are given by the foreman. The size of the heading, the unit prices, and any details differing from usual practices are specified on a written memorandum, a copy of which is given to the contractor. Stope contracts are given on a cubic-meter basis. Contractors pay for labor, carbide, and explosives. Liquidations are made weekly. Measuring for contract payments is a large part of the work of the engineering department. Weekly liquidations give the operating department a close check on the work being done by each contractor, so that unsatisfactory conditions can be remedied at once. Contractors failing to make expenses for three consecutive weeks may be removed.

Contractor's men are paid their full wages through the company office; and, in addition, an amount equal to one-third of the contractor's net earnings (gross earnings less deductions for explosives and labor at full wages) is divided among them. The contractor receives the full amount of the net earnings from his contract. Thus the contract may be termed a participating contract in which each man shares in the profits.

Safety Work Emphasized

Safety—Inspectors are employed to supervise blasting in the sulphide mine, inspect stopes for missed holes, and report any details which are considered unsatisfactory from a safety standpoint. Typewritten reports are made daily to the bosses concerned, and at weekly meetings a check is made on the action taken on recommendations. The inspectors work under supervision of a safety engineer and in close cooperation with the operating staff in foreseeing and eliminating hazards to safety.

Every man receiving an injury, regardless of its severity, is sent to the hospital. The injury is classified either as slight, minor if less than three days' time is lost, or serious if more than three days are lost.

In the years 1932 to 1935 inclusive the accident rate per 1,000 shifts worked is as follows: Fatal, 0.013; serious, 0.021; minor, 0.268; slight, 1.669. Total, 1.971.

A fire car, containing axes, hoses, wrenches, pipe fittings, and other material and tools necessary for fire fighting, is maintained; and water connections and hydrants are placed underground where considered necessary. At monthly fire drills, bosses inspect equipment and extinguish theoretical fires. A stench signal using ethyl mercaptan is in readiness to spread the warning of a fire underground through the compressed-air system. McCaa-type oxygen apparatus is kept at the mine, and crews are trained in its use.

I am greatly indebted to T. C. Baker, general manager of the Fresnillo Company, for many suggestions made during the preparation of this article and for editing it when completed.

How Much Heat Is Removed From the Mine By the Ventilating Current?

The method of determining it is explained, with calculations . . . An important matter today when the problem of high temperatures underground is attracting more and more attention

Walter S. Weeks
Professor of Mining
University of California
Berkeley, Calif

TO DETERMINE the rate at which heat is being removed from a mine or section thereof, one must know the enthalpy of the "air" that has passed through, at the entrance and at the exit. The "air" is in reality a mixture of dry air and water vapor. To facilitate the calculation of total enthalpy it is customary to first calculate the enthalpy per pound of dry air. This I shall call unit enthalpy.

The unit enthalpy of the air-vapor mixture may be defined as the amount of heat required to raise, under constant pressure conditions, 1 lb. of dry air from an assumed base temperature to the dry-bulb temperature, plus the amount of heat necessary to change a weight of water equal to that of the vapor associated with 1 lb. of air, from water at an assumed temperature, to vapor under the conditions existing in the atmosphere. A commonly assumed base temperature for the air is 0 deg. F. and for the vapor 32 deg. F.

If the relative humidity is 100 per cent, the enthalpy of the vapor per pound may be taken directly from the "total heat" column of a table giving the properties of saturated steam.

If the relative humidity is less than 100 per cent, the vapor in the air is superheated. The calculation of the enthalpy of superheated vapor is simplified by the fact that, at low pressures, its enthalpy is the same as the enthalpy of saturated vapor at the temperature of the superheated vapor, which in this case is the dry-bulb temperature.

Enthalpy of 1 lb. of dry air:

$E_a = C_p T$
E_a = Enthalpy 1 lb. dry air. (B.t.u.)
C_p = Specific heat dry air at constant pressure. (B.t.u. per lb. per degree F.)
T = Dry-bulb temperature. (Deg. F.)

Enthalpy of vapor associated with 1 lb. dry air:

$E_v = WE_1$.
E_v = Enthalpy of vapor associated with 1 lb. dry air. (B.t.u.)
W = Weight of vapor associated with 1 lb. dry air. (Pounds)
E_1 = Enthalpy 1 lb. saturated vapor at dry-bulb temperature. (B.t.u.)

Weight of vapor associated with 1 lb. air:

$$W = 0.622 \frac{e}{P - e}$$

e = Vapor pressure at dew point
P = Barometric pressure.

This equation is derived as follows:

Consider 1 pound-mole of dry air containing moisture. The partial pressure of the vapor in the air is the vapor pressure at the dew point. If the barometric pressure is P and the partial pressure of the vapor is e, the partial pressure of the air is $P - e$, and the volume occupied by 1 mole of the air is

$$V = \frac{RT}{P - e}$$ where R is the universal gas constant and T the absolute temperature.

The volume occupied by 1 pound-mole of water vapor is

$$V_1 = \frac{RT}{e}$$

The number of moles of water vapor associated with 1 mole of air is

$$\frac{V}{V_1} = \frac{e}{P - e} \text{ moles.}$$

One pound-mole of air weighs 29.98 lb. and 1 pound-mole of water vapor weighs 18.02 lb., so the number of pounds of water vapor associated with 1 lb. air is

$$W = \frac{e}{P - e} \times \frac{18.02}{29.98} = 0.622 \frac{e}{P - e}$$

Unit enthalpy of mixture:

$$E_m = C_p T + 0.622 \frac{e}{P - e} E_1$$

E_m = Enthalpy of mixture per pound dry air.

The groundwork being now established, an actual calculation may be undertaken. Let the following assumptions be made: A mine has an upcast and a downcast shaft, the collars of which are at the same elevation.

The barometric pressure at the surface is 30 in. mercury. At the top of the downcast shaft, the dry bulb is 70 deg. F., the wet bulb 60 deg. F., and the dew point 53.5 deg. F. The air coming out of the upcast shaft is saturated at 80 deg. F.; that is, dry bulb, wet bulb, and dew point are all 80 deg. F. The fan is circulating 100,000 cu.ft. per minute measured at the top of the downcast shaft. How much heat is being removed from the mine each minute?

Unit enthalpy of intake air:

$E_m = C_p T + WE_1$

$$W = 0.622 \frac{0.413}{30.0 - 0.413} = 0.0087 \text{ lb.}$$

Enthalpy 1 lb. saturated vapor at 70 deg. F. = 1090.3

$E_m = 0.241 \times 70 + 0.0087 \times 1090.3 = 26.36$

Unit enthalpy of outgoing air:

$$W = 0.622 \frac{1.029}{30.0 - 1.029} = 0.022 \text{ lb.}$$

Enthalpy 1 lb. saturated vapor at 80 deg. F. = 1094.8

$E_m = 0.241 \times 80 + 0.022 \times 1094.8 = 43.37$ B.t.u.

Gain in unit enthalpy in passing through mine = 43.37 — 26.36 = 17.01 B.t.u.

Weight of dry air per minute:
The weight of the air per cubic foot may be determined from the formula

$PV = wRT$
P = Partial pressure of the air in lb. per square foot
V = Volume in cubic feet
w = Weight in pounds
R = Constant for air = 53.3
T = Absolute temperature in deg. F.

The partial pressure of the vapor in the mixture is the vapor pressure at the dew point, so the partial pressure of the air is

$P - e = 30.0 - 0.413 = 29.59$ in. Hg. = 14.53 lb. per square inch.

$$\text{Weight of air per cubic foot} = \frac{PV}{RT} = \frac{144 \times 14.53 \times 1}{53.3 \times 530} =$$

0.074 lb. per cubic feet

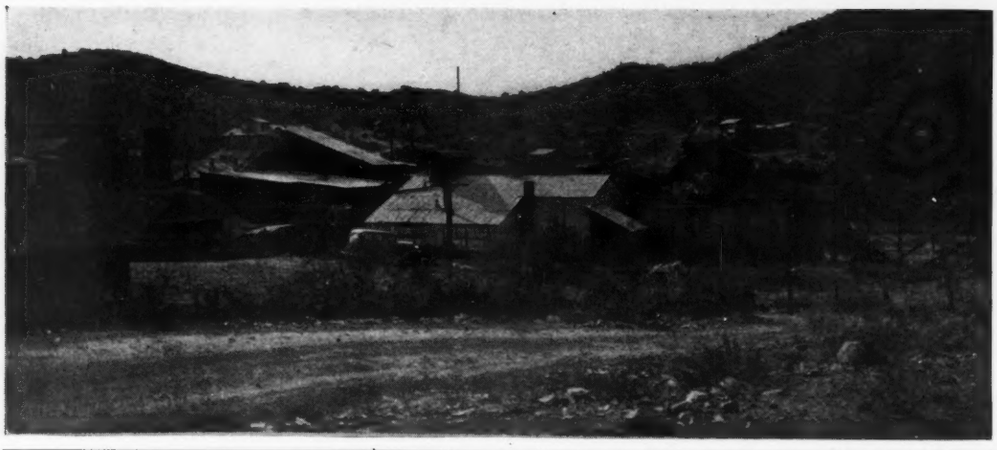
100,000 cu.ft. of the mixture contains 100,000 × 0.074 = 7,400 lb. dry air.

Heat removed per minute:

$7{,}400 \times 17.01 = 125{,}874$ B.t.u.

If from this figure is subtracted the heat generated in mining operations, the result is the heat taken from the rocks and water of the mine. If it is assumed that the enthalpy of the water in the mine is supplied by the warm rocks, then this result is the heat taken from the rocks.

(Continued on page 289)



MOLYBDENUM GOLD MINING COMPANY

operates this 200-ton flotation plant on ores from its Mohawk and New Year mines. About 100 tons a day is also treated from the near-by Mammoth mine

GOLD AND MOLYBDENUM . . .

J. B. Huttl

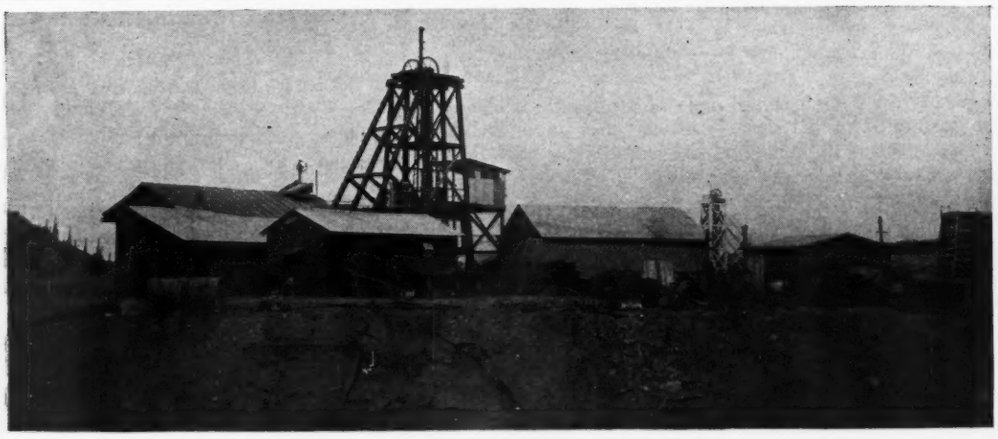
Assistant Editor

MINING in the historic Mammoth district in Arizona has passed through several phases, and at present there is a revival of activity which is attracting widespread attention of Western mining men. Healthy signs are found in the awakened interest of Eastern and Pacific Coast capital in mining, and the greater ease with which its assistance is now obtained in the opening up of good prospects and in the rehabilitation of some of the abandoned mines during the past two years. This condition has been brought about by the persistency of responsible companies active in the district and the results obtained in the Copper Creek and Old Hat areas. Both camps are within a radius of 13 miles from the old town of Mammoth, on the San Pedro River, and can be reached over good roads. Their respective elevations are 4,100 and 3,200 ft.

Copper Creek is not a new camp. In fact, the old silver mines covering the central part of the basin were worked previous to 1893, when the price of the metal declined. After this the camp was worked intermittently by different companies, mainly for its copper ores, and at one time—during the period 1910-12—boasted of a large number of active mines, among which were the Globe, Giant, Reliable, Reliable Eastern, Prince, and American Eagle, and a 250-ton concentrator. Although the copper orebodies appear to belong to the class of disseminated deposits, they differ in many respects from the near-by orebodies of the Kelvin-Globe districts.

Though the disseminated copper ores at Globe and Ray consist of chalcocite carried in the Pinal schist, the Copper Creek orebodies are found principally in masses of brecciated and altered diorite, carrying pyrite, chalcopyrite, and bornite. In general, the orebodies outcrop in well-defined masses of brecciated rock, stained with iron and copper, and oxides and carbonates are found at surface, often in commercial quantities, but these give place at shallow depth to sulphides. Within the orebodies occur zones of leached rock as well as shoots of richer ore, there being no rule or regularity in these occurrences. Recent work done in the lower end of the basin has disclosed brecciated and mineralized zones carrying both molybdenite and copper minerals in the diorite where there was little or no surface indication of an orebody.

In the Mammoth district proper, sometimes considered part of the Old Hat district, two companies are active. Molybdenum Gold Mining Company, a subsidiary of Molybdenum Corporation of America, is working the New Year and Mohawk claims, acquired in 1933, and Mammoth-St. Anthony, Ltd., is developing the old Mammoth mine. Both properties are about 3 miles southwest of the town of Mammoth. The history of the district dates back to 1881, though prospecting was done in the Mammoth vicinity prior to the Civil War. As at Copper Creek, the mines have been worked intermittently since their discovery and are accredited with a gold production exceeding $3,000,000. They were rehabilitated by the present owners in 1933.



MOHAWK AND NEW YEAR SHAFTS

near Mammoth, Ariz. Both shafts are 600 ft. deep. The Mohawk is in the center foreground and the New Year two-compartment shaft is in the right center

THREE-COMPARTMENT MAMMOTH SHAFT

It is equipped with 2-ton automatic skips operated by a 100-hp. double-drum hoist and is 700 ft. deep. The mine produces about 3,000 tons a month of complex ore

From Rehabilitated Mines in Mammoth, Arizona

The veins in the district occur within shear zones which strike west-northwestward and dip steeply southwestward. Gangue consists of brecciated country rock, cemented and replaced with quartz and calcite, together with some barite and fluorite. The gold generally is fine grained, but in places its particles are visible. In the oxidized zone are limonite, hematite, anglesite, cerussite, linarite, brochantite, malachite, azurite, calamine, wulfenite, vanadinite, pyromorphite, descloizite, cuprodescloizite, and pyrolusite. Galena, sphalerite, and sparse molybdenite occur as hypogene minerals. In the Mohawk and New Year mines the permanent water level is at 625 ft., and the extent of oxides below this level is not known. At the adjoining Mammoth mine, oxidation is complete to the 700-ft. level.

The Mohawk and New Year mines of Molybdenum Gold Mining Company are developed by two shafts 600 ft. deep, and all mining operations are conducted in the oxide zone. Ore occurs in rhyolite-brecciated veins from 4 to 30 ft. wide, which are mined by shrinkage stoping methods. The 200-ton mill built in 1933 is treating about 200 tons of ore a day. Of this tonnage half, or 100 tons a day, is received from the neighboring Mammoth mine. The ore is treated by flotation methods. Because of the complex nature of the ore, the flowsheet of the mill is somewhat elaborate. Mine-run material is crushed successively in a gyratory crusher, a 2-ft. Symons cone crusher, and a set of rolls, which is followed by grinding in a No. 64½ Marcy ball mill operating in closed circuit with eight-mesh Leihy screens. The minus eight-mesh product goes to Deister tables. Tailings from these tables are reground in a second ball mill operating in closed circuit with a Dorr classifier, the minus 65-mesh overflow passing to Denver Equipment flotation cells. Concentrates, after receiving final treatment in a continuous filter, are shipped to the Chemical Works at Washington, Pa. They contain gold, molybdenum, vanadium, and lead. Plans are under way to increase the capacity of the mill to 400 tons. Fred Marston, general manager, is in charge of operations.

Considerable development work is in progress at the Mammoth mine, adjoining the Mohawk and New Year properties on the west. Mammoth-St. Anthony, Ltd., the owners, is controlled by the Wilton Lloyd-Smith interests, with F. S. Naething, consulting engineer, directing operations. The mine is opened by a three-compartment vertical shaft, which was recently equipped with 2-ton self-dumping skips and a 100-hp. double-drum hoist. A new shaft is being sunk in the vicinity of the old Collins glory hole for ventilation and supply of materials. Underground exploratory work is carried on according to formulated plans, and blocked-out ore is stoped by cut-and-fill methods. Monthly production exceeds 3,000 tons, which is trucked to the Molybdenum Gold Mining Company's mill, as mentioned previously. Compressor equipment consists of one IR unit and a C-P machine. About 1,000,000 gal. of water a month is pumped from the mine by a large Aldrich pump and sold to Molybdenum Gold Mining Company. E. A. Stone is superintendent.

THE 200-TON MILL

of the Molybdenum Gold Mining Company at Mammoth, Ariz., in another view. At the right are the New Year and Mohawk shafts

Are American Employers Interested in Their Employees?

• A survey of 2,452 business establishments reveals diversity of commendable activities in the interest of employees. Mining companies are specially active in medical, recreation, safety, health, insurance, and housing programs

THERE is a general consensus of opinion that the economic status of the American worker is superior to that of labor in any other country. If this were only American opinion it might be open to question; but it has been so frequently corroborated by visiting students of labor problems who have come here to study American employer-employee relations that it can be accepted as a fact. And yet during the last few years there has been a persistent effort, largely through the channels of government, to discredit the interest of American business concerns in their employees, and to convey the impression that government has found it necessary to intervene on behalf of the worker and protect him against the indifference, if not the callous disregard, of employers.

Hence the timely value of the publication of "What Employers Are Doing for Employees," a study by the National Industrial Conference Board, New York. Believing that the public ought to have accurate information on which to base its judgment of American labor policy, the Conference Board made an elaborate survey of voluntary activities for improvement of working conditions in American business concerns. The result is a compilation showing not only the numerous and varied types of activity, but also the scale on which industrial relations programs are carried on by manufacturing and non-manufacturing groups, in large and small plants, in different parts of the country. Analysis of the data shows a broad and steadily increasing consideration of the worker, propaganda to the contrary notwithstanding.

Information for the study was obtained from questionnaires listing about 90 activities or policies affecting the employer-employee relationship. Replies were received from 2,452 establishments employing 4,502,608 persons, covering an unusually broad and representative cross-section of American business. The great majority of replies, 2,075, came from manufacturing concerns. Of the 377 in the non-manufacturing group 28 were from mining companies.

Examination of the group as a whole reveals some interesting trends. Collective bargaining, which gained momentum under NIRA and continued effective under the National Labor Relations Act, is conducted either through employee representation groups or organized labor unions. Employee representation plans have grown in favor, as shown by the fact that such plans are operating in over 30 per cent of all the reporting companies in the present survey. A similar study in 1927 showed only 5 per cent of companies with this activity. Trade union agreements were reported by over 11 per cent of the companies in the present survey. There are no comparable figures for 1927.

Among activities tending to improve the employee's economic security, group life insurance holds first place. It prevails in the largest number of reporting companies and affects the largest number of employees. Next in order come active plans for loans to employees, group health and accident insurance, mutual benefit associations, informal pensions, dismissal compensation, and formal pensions.

Financial incentives find wide adoption. Piece work, premiums, or bonus systems head the list, followed by suggestion systems, patent agreements with employees, foreman's incentives, and bonuses for quality, service, and attendance.

In the thrift and investment group of activities, savings plans are most popular, prevailing in over 15 per cent of the reporting companies. Credit unions, stock purchase plans, building and loan associations, and home purchase plans follow in the order named. Stock purchase plans suffered disaster in 1929 and subsequent years, turning well-intended benefits into losses. These plans are tending rapidly to diminish.

Employee training plans for self-improvement were reported by over 34 per cent of the companies. Apprentice training is the commonest form of this activity. Others cover the training of foremen, disabled men, and semi-skilled labor. Cooperative training courses are carried on in some companies through employers' associations and the public schools. A director of training is employed by 90 of the reporting companies.

Educational facilities of various kinds are offered by different concerns. More than one hundred have educational directors, and 84 provide continuation schools. Libraries and reading rooms are numerous, and employees' magazines are a feature of educational activities.

Perhaps the most impressive record is made by company provisions for the physical welfare of employees. Medical service of some kind is provided by over 65 per cent of the companies employing more than 93 per cent of the workers covered by the report. Organized first aid heads the list, but 1,154 companies have hospitals or dispensaries, 867 have plant nurses, and 366 have visiting nurses. Physicians, part-time, full-time, or on call, are available in hundreds of companies for millions of employees. Dental and optical clinics, though not so numerous as hospitals and dispensaries, are maintained by 113 and 179 companies, respectively. Physical examination of new employees is given by nearly half the reporting companies, and 20 per cent of them make periodic examinations of all employees.

Improvement in working conditions is notable also in the conveniences and privileges provided for employees. The use of the automobile for going to and from work has created a new problem for companies having limited space for parking. Nevertheless, 1,459 companies in the survey have provided such facilities. There is, of course, widespread provision of sanitary conveniences. Cooperative purchasing, cooperative stores, and luncheon facilities are provided for millions of workers.

Rest and recreation activities are widespread. More than 1,100 companies have athletic programs, and more than 1,000 have organized teams. Club and community houses are numerous. Dances, dramatics, gardens, outings, and summer camps are among the social activities. Holidays and vacations with pay are becoming more common, for wage earners as well as for clerical workers. Rest rooms and rest periods are provided for men as well as women.

General personnel policies have im-

proved greatly over the old days of indiscriminate hiring and firing. Centralized employment, discharge, and transfer now eliminate favoritism and promote fairness among employees. The five-day week for wage earners prevails in 1,404 of the reporting companies, and for clerical workers in 1,110 concerns. A definite lay-off procedure is reported by over 20 per cent of the establishments.

There is a growing recognition of the value of job analysis and specification, and of systematic promotion. Rating systems and employment tests of one kind or another are being increasingly adopted.

Miscellaneous activities such as dormitories, housing, legal aid, service emblems, and uniforms round out the list of more than 90 items included in the survey.

Finally, a comparison is made showing the prevalence of certain activities among the companies reporting in 1927 and in 1935. Marked percentage increases are shown in quality bonus, benefits for death, accident, and sickness, group life, health, and accident insurance, pension plans, savings plans, apprentice training, and employee representation.

The foregoing summary is recited in some detail, even at the risk of monotony, because it refutes conclusively the notion that employers are indifferent or blind to the personal interests of employees. Unquestionably they support activities that are beyond the scope of government or the benefit that can be conferred by organized labor.

As for the mining industry, analysis of all the data shows commendable activity in group insurance, mutual benefit associations, pensions, relief funds, credit unions, libraries and reading rooms, medical programs, hospitals, first aid, physical examinations, safety, athletics, club rooms, personnel policies, and housing facilities.

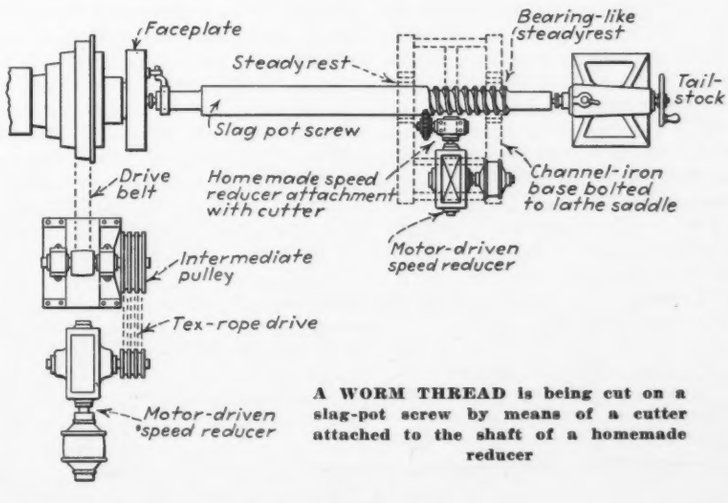
In presenting the study the National Industrial Conference Board points out that "the need and desires of different working groups vary and that a program which is highly successful in one company may be ineffective or distasteful to another group of employees. Each company has its own problem. In dealing with this problem the experience of other companies is exceedingly helpful, but it should be recognized that the policies of other employers must be adapted to the particular situation and not adopted without discrimination."

• • •

Cutting Worm Threads In a Lathe

ONE of the most time-consuming and costly jobs done at times at the machine or repair shop is cutting worm threads on large shafts. When employing conventional methods this is done in several stages, necessitating frequent stoppage of the lathe for inspection purposes and change of tools. At the smelter machine shop of Phelps Dodge Corporation, Douglas, Ariz., the problem of cutting the worm threads on a number of slag-pot screws at the lowest possible cost was satisfactorily solved by the simple set-up explained in the accompanying line cut, according to Lee Adamson, foreman.

As will be seen, the threads are milled in by a cutter secured to the shaft of a homemade speed-reducer attachment driven by a small speed reducer. The complete unit is mounted on a sturdy base, made from channels and strap iron, which is secured to the lathe saddle by four bolts. To avoid chattering and provide for smooth rotation of the slag-pot screw held by the live and dead centers of the lathe, the base is also fitted with two bearing-like steadyrests. Motive power for the lathe proper, and the slow speed required for milling in the threads in one operation, are provided by a motor-driven speed reducer and an intermediate pulley unit. The arrangement described has reduced the time for cutting the worm threads on the slag-pot screws from ten to two eight-hour shifts.



A WORM THREAD is being cut on a slag-pot screw by means of a cutter attached to the shaft of a homemade reducer

•

How Much Heat Is Removed From the Mine By the Ventilating Current?

(Continued from page 285)

If, however, the mine is dry and the rocks are sprayed with water from the surface, say at a temperature of 60 deg., enthalpy is being introduced into the mine, and the outgoing enthalpy of the atmosphere includes some of this introduced enthalpy.

Assuming air conditions at entrance and exit as in the problem, each pound of dry air has taken up $(W_2 - W_1)$ pounds water that was handed to it at 60 deg. The introduced enthalpy per pound of dry air is

$$(0.022 - 0.0087)(60 - 32) = 0.37 \text{ B.t.u.}$$

Introduced enthalpy removed

$$7{,}400 \times 0.37 = 2{,}738 \text{ B.t.u.}$$

This much of the heat removed is not taken from the mine.

If the mine contained no moisture, and none is introduced, assuming that the rock temperature at the moment is 80 deg. F., the air would leave the mine at a dry-bulb temperature of 80 deg. and the original dew point. In this case the final unit enthalpy is

$$E_s = 0.241 \times 80 + 0.0087 \times 1094.8 = 28.80$$

$$\Delta E_s = 28.80 - 26.36 = 2.44 \text{ B.t.u.}$$

Heat removed from the mine per minute:

$$7{,}400 \times 2.44 = 18{,}056 \text{ B.t.u.}$$

From this analysis it is clear that if it is desired to cool the wall rocks quickly, the air should be made to take up water. If the section is dry, cooling may be hastened by spraying.

After introducing the moisture the air should be taken to the upcast as soon as possible, for the high dry bulb combined with high dew point will cause a high wet-bulb temperature, which means unfavorable working conditions. While the section is being cooled it may even be impossible to work there on account of the low "cooling power" of the air.

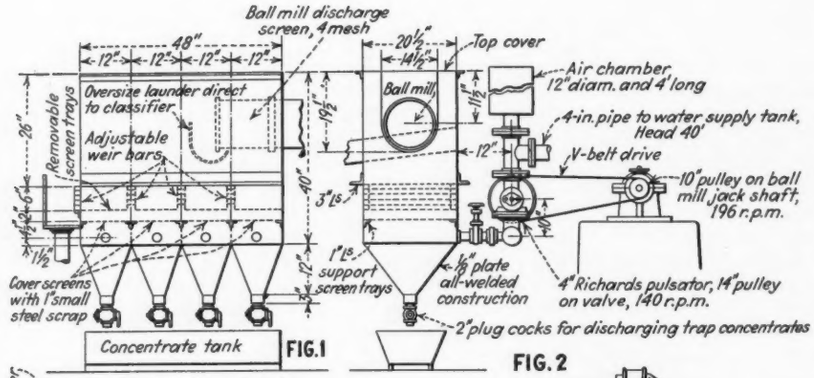

Ball mill discharge screen, 4 mesh
48"
12" 12" 12" 12"
20½"
14½"
Top cover
Air chamber 12" diam. and 4' long
Oversize launder direct to classifier
Ball mill
4-in. pipe to water supply tank, Head 40'
Removable screen trays
Adjustable weir bars
V-belt drive
10" pulley on ball mill jack shaft, 196 r.p.m.
3"Ls
1"Ls. support screen trays
½" plate all-welded construction
4" Richards pulsator, 14" pulley on valve, 140 r.p.m.
Cover screens with 1" small steel scrap
2" plug cocks for discharging trap concentrates
Concentrate tank

FIG. 1

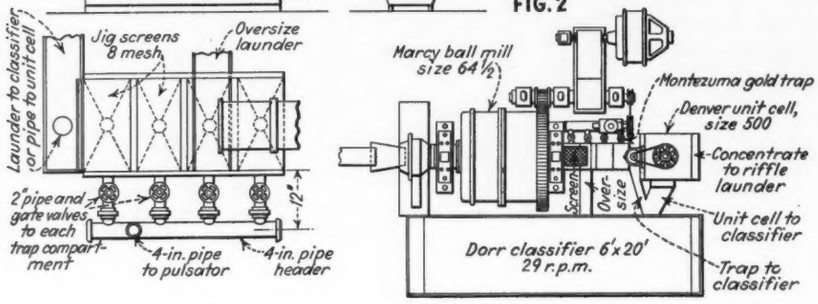

Launder to classifier or pipe to unit cell
Jig screens 8 mesh
Oversize launder
Marcy ball mill size 64½
Montezuma gold trap
Denver unit cell, size 500
Concentrate to riffle launder
Screen
Over-size
Unit cell to classifier
2" pipe and gate valves to each trap compartment
4-in. pipe to pulsator
4-in. pipe header
Dorr classifier 6'x20' 29 r.p.m.
Trap to classifier

FIG. 2

Hydraulic Gold Trap Improves Recovery

DEVELOPMENT of a gold trap by the Montezuma-Apex Mining Company, at Nashville, Calif., has greatly increased metallurgical efficiency at the 250-ton flotation mill, according to J. A. Norden, general manager. Values recovered here are in the form of metallic gold and gold associated with sulphides of iron, together with small amounts of antimony, bismuth, copper, and lead. The former constitutes about 50 per cent of the total values in the ore. The gold particles in general are fine. Their recovery offered a problem prior to installing the gold trap, which has become known on the Mother Lode as the Montezuma gold trap. Until the device was perfected, the metallic gold was recovered by riffled launders interposed between the ball mills and classifiers, followed by a series of pulp-sifting tables. Though a fairly good recovery was made, the process proved cumbersome, for the entire plant had to be shut down at intervals for clean-up purposes, not to mention the extra floor space required for the cloth tables. This condition has been improved materially by installation of the arrangement shown in Fig. 2.

As will be seen, the hydraulic trap is operated in conjunction with a Denver unit cell, which makes a most effective combination of equipment for the recovery of free gold as well as most of the ore values in the grinding circuit. As a matter of fact, these two simple machines will do nearly as well as the ordinary stamp mill where amalgamation plates are followed only by vanners or tables.

As an illustration of this, the feed at the Montezuma mill ranges between 0.15 0.30 of an ounce of gold per ton. With this type of feed the classifier overflow, which is sent to other flotation cells for additional treatment, ranges between 0.04 and 0.06 of an ounce per ton, and the lower values generally accompany the higher-grade ore. The concentrate product of the unit cell assays between 6 and 12 oz. per ton. This is passed over riffles and a pulp-sifting cloth. Riffle tailing, containing from 4 to 5 oz. of gold per ton, is shipped to the smelter with other flotation concentrate, and the riffle concentrate, assaying from 30 to 40 oz. per ton, and the trap product, with a gold content of 60 or more ounces, are amalgamated. Amalgamation is done in a barrel, which is cleaned up in a mechanical batea. The residue, containing from 5 to 6 oz. per ton, is shipped to the smelter with flotation concentrates.

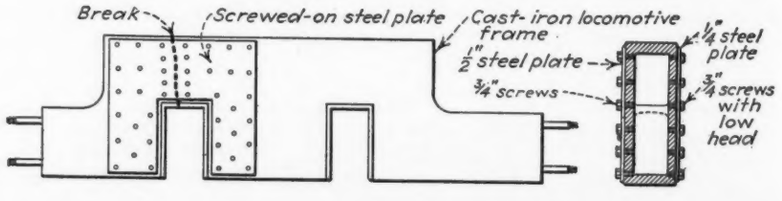
On account of the carbon contained in the ore, it is impossible to cyanide it or any of the concentrate products. Final flotation is done in a ten-cell, 30-in. Agitair flotation machine, producing a concentrate containing 1.5 oz. gold per ton. This product is cleaned in an eight-cell, 24-in. Agitair machine. Cleaner concentrate assays 2 to 2.5 oz. per ton. The cleaner tailings and primary tailings flow together by gravity to the tailings pond. They assay from 0.08 to 0.10 and 0.008 to 0.012 oz. per ton respectively. Combined tailings contain from 0.01 to 0.015 oz. per ton. The cleaner tailings are not returned to the primary cells as in conventional practice, because of the large amount of slime contained, which creates a condition detrimental to good recovery. Reagents used in the primary circuit are amyl xanthate, Aerofloat 15, cresylic acid, sodium sulphide, and copper sulphate. In the cleaner circuit tapioca starch and ethylene dichloride are used, together with a very small amount of amyl xanthate and some additional copper sulphate. The concentrate is practically neutral so far as iron and insoluble content are concerned.

The construction of the gold trap proper is explained in Fig. 1. In principle it is not unlike a pulsator jig. The trap body is made from ⅛-in. plate, welded, and houses a series of removable screens and adjustable weirs. Pulsion and suction are effected by a 4-in. Richards pulsator operated at 140 r.p.m. Water is obtained from a supply tank under a 40-ft. head. Concentrates collected in the hutch chambers are drawn off through 2-in. plug cocks and stored in a wooden tank. Total floor space required for the installation shown in Fig. 2 is 30x32 ft.

•

Electric-Locomotive Frame Repair

RECENTLY the master mechanic of a leading silver mine in Utah was faced with the problem of repairing quickly the broken frame of a 7-ton electric locomotive, to avoid a long interruption of ore haulage to the mill. The damage was caused by the locomotive jumping the track in the main haulage tunnel because of an improperly set switch, the impact breaking the sides of the frame at the point indicated in the accompanying sketch. Unfortunately, the locomotive frame was of cast-iron construction and could not be welded satisfactorily with the welding outfit available at the repair shop. In addition, it was questioned whether the welded joints would stand the stress and strain the frame was subjected to when on the tracks. The difficulty was finally overcome by securing two steel plates to the sides of the frame as indicated in the cut. As the void between the frame walls did not permit the use of rivets, the outer plates, ½ in. thick, were attached by ¾-in. standard screws and the inner plates by ¾-in. screws, with short heads.



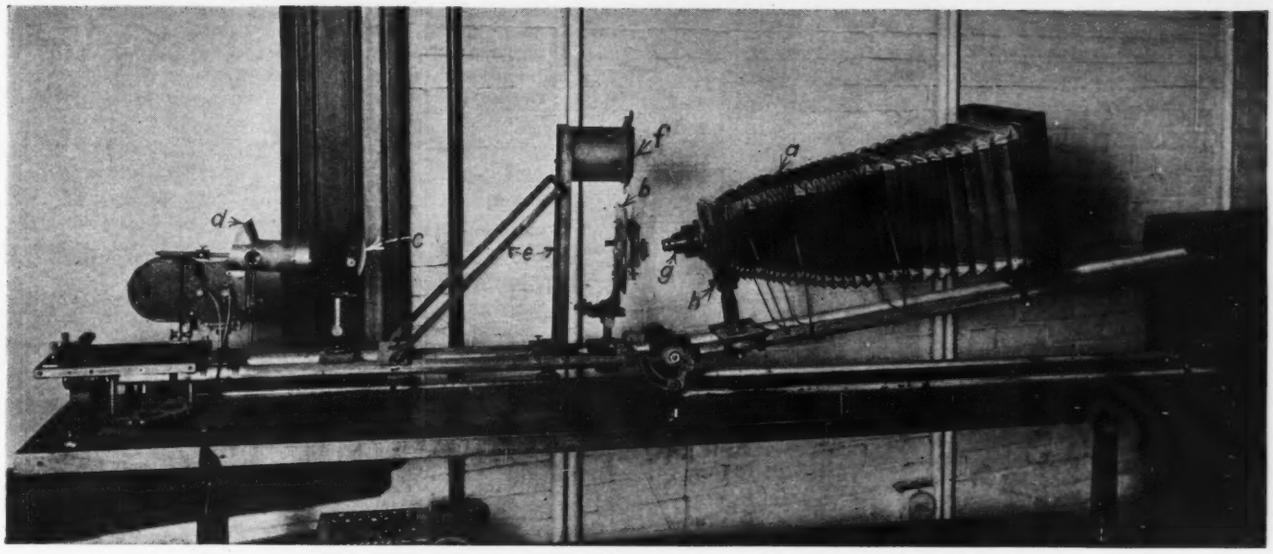


FIG. 1. . . . THE BUBBLE MACHINE (after Taggart, Taylor, and Ince), for measuring the angle of contact between bubble and mineral particle at the line of three-phase contact—air or oil, mineral, water. The letters denoting the various parts are explained in the text

The Bubble Machine

For Flotation Testing

With a modification in its construction and a changed technique of using it, the results obtained with it in measuring contact angles are now readily reproducible

Guido R. M. del Giudice

Lecturer in Mineral Dressing, School of Mines, Columbia University, New York

THE BUBBLE MACHINE is an apparatus for measuring contact angles at the line of three-phase contact—air or oil, mineral, water. The significance of these contact angles has been discussed by Taggart, Taylor, and Ince[1]; Wark and Cox[2]; Shepard[3]; and del Giudice.[4]

Taggart, Taylor, and Ince[5] were the first to use the bubble machine for obtaining a semiquantitative measure of the effect of collecting agents. Since then, Wark and Cox[6] have modified slightly the original set-up and have completely changed the preparative technique. They have standardized the procedure and have rationalized the results obtained from the bubble machine to such an extent that they have felt justified in using it as a fundamental tool in their researches.[7, 8, 9, 10, 11]

Indeed, the bubble machine is becoming more and more important as a testing and research tool in the hands of flotation investigators.[12]

Fig. 1 shows the bubble machine of Taggart, Taylor, and Ince.[12] It consists essentially of a photographic camera, *a*, onto which a photographic lens of short focus, *g*, is mounted; a cell stage, *b*; a frame, *e*, on which is mounted a mechanical stage from a microscope, *f*; a plano-convex condensing lens (a bullseye condenser), *c*; and an arc lamp, *d*. For convenience and for added ease in obtaining proper alignment of the component parts, these are mounted on suitable clamps, which in turn can be mounted on the slides of an optical bench.

The camera is fitted with a ground glass ruled in centimeter squares and with a shutter for photographic purposes. The lens-end of this camera is fitted with rack-and-pinion mechanism, *h*, for focusing. The photographic lens is mounted on the camera at *g*.

A short-focus lens with built-in aperture diaphragm is desirable. This aperture diaphragm is kept fully opened for visual observations, but it becomes almost indispensable when photography is attempted. The Leitz 64-millimeter Summar serves the purpose admirably. Extending or closing the bellows of the camera permits the realization of a wide range of magnifications. A magnification of 15X to 20X will serve for routine testing.

The cell stage may be complicated or simple in design. Fig. 2 is a drawing showing the front and side views of the cell stage now used in the Mineral Dressing Laboratories of Columbia University. The cell rests on a screw-head *B*, which may be lowered or raised in order to center the image on the ground glass of the camera. Two additional screw-heads, *A-A*, are used to hold the cell in place. Screw-heads *A-A* and *B* are mounted on a frame, which can rotate about the axis in order to level the test-particle surface. The entire frame is fixed to a screw-rack, *C*, which imparts motion to the frame along the optical axis of the bubble machine, for focussing.

Fig. 3 shows the bubble machine cell in its present form. It consists of a bakelite frame (*a*) onto which two pieces of 3x3½x⅛-in. plate glass (*b-b*) are cemented with "Duco" household cement. One surface of one of the pieces of plate glass is ground, and the

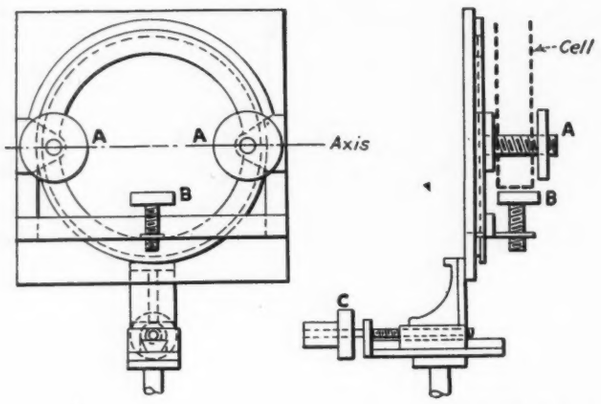


Fig. 2. . . . CELL STAGE of the bubble machine ("b" in Fig. 1), in front and side view. "A, A" are screw heads, used to hold the cell in place. "B" is a screw head which may be lowered or raised to center the image on the ground glass of the camera. "C" is a screw rack, employed in focussing

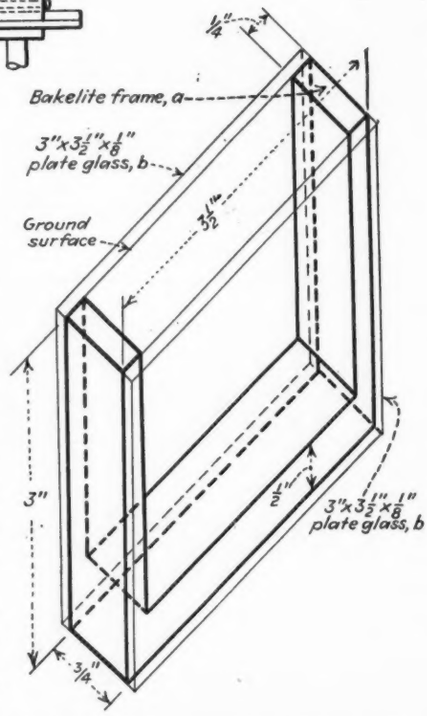


Fig. 3. . . . THE CELL, made of bakelite and glass. It is constructed by joining two pieces of plate glass to a bakelite frame with Duco household cement. One surface of one of the pieces of glass is ground, this being placed toward the light source when the cell is set on the stage

cell is always placed on the cell stage with the ground-glass side toward the source of light. After some four to six hours' use, the glass sides usually become loose and must be recemented. This is a desirable situation because it permits periodic thorough cleaning. The entire cell can be cleaned with cleaning mixture (chromic acid solution) without any damage to the bakelite frame or to the cement. The cell has been made $\frac{3}{4}$ in. thick because the rack-and-pinion mechanism on the camera is of such length that it has a focussing range of about this distance.

The frame *e*, Fig. 1, may be of any suitable design. Its purpose is to hold a mechanical stage from a microscope, Fig. 4, or any similar mechanism, above the cell stage.

Fig. 4 shows the mechanical stage, which will give side-to-side motion across the optical axis of the system by means of screw-head *B*, and up-and-down motion across the optical axis (in order to raise or lower the bubble holder) by means of screw-head *A*. Screw-head *C* simply clamps screw-head *B*, so that after the bubble holder (Fig. 5), which is mounted on the microscope stage through a sleeve brazed onto the stage mechanism at *D*, is centered with respect to the particle surface and testing has commenced, there will be no danger of accidental side-to-side slip while proceeding with the test.

Fig. 6 is an assembly of the microscope stage with the bubble holder mounted and in the cell as in the course of a test.

The plano-convex lens (bullseye condenser) may be of any suitable focal length. It must be mounted with the plane side toward the shorter conjugate focus and must be placed, with respect to the photographic lens and the arc lamp, so that it forms an image of the crater of the arc lamp approximately at the center of the aperture diaphragm of the photographic lens. By taking this precaution, proper illumination of the

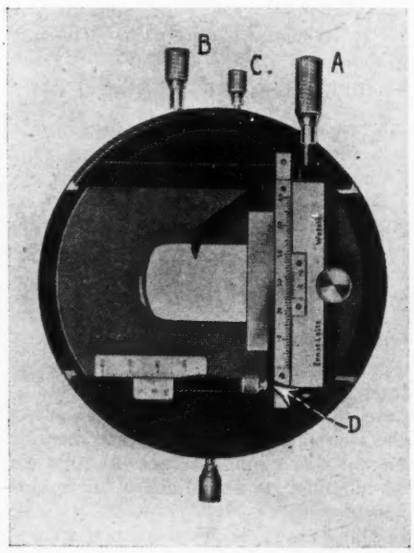


Fig. 4. . . . MECHANICAL STAGE, taken from a microscope and which serves as a mounting for the bubble holder, permitting it to be moved sideways or up and down across the axis of the system by means of the set-screws "A" and "B" respectively. Screw head "C" serves to clamp "B" to prevent accidental slipping of the bubble holder

field on the ground glass of the camera will be obtained and the brightness of the image may be reduced or increased at will by reducing or increasing the aperture of the lens by means of the aperture diaphragm. For the sake of accuracy, some investigators may prefer to measure the angle of contact on a photograph instead of on the image obtained on the ground glass of the camera. As stated in the foregoing, the aperture diaphragm is almost indispensable for such photographic purposes. However, the angle may be measured with sufficient accuracy directly on the ground-glass screen of the camera itself.

The only change which the years have brought in the bubble machine is in the position of the photographic camera. In the original arrangement of Taggart, Taylor, and Ince, the camera, with the photographic lens, was in a horizontal position, as in Fig. 1; that is, the optical axes of the camera and of the photographic lens were in the optical axis of the rest of the apparatus. Wark and Cox in their first paper,[14] state:

"It has been found desirable to place the lamp in a plane slightly higher than that of the surface of the mineral. Light is then reflected from the mineral surface and the image of the bubble on the screen is seen in juxtaposition with an inverted image which arises by reflection at the surface of the mineral."

It has been found, however, that, at least with the arrangement shown in Fig. 1, the change suggested by Wark and Cox does not produce the desired effect. However, by inclining the camera, the results described by Wark and Cox are readily obtained. When this is done, in order to obtain proper illumination, it becomes necessary that one of the glass sides of the cell is ground, as already stated.

The image obtained when this is done is preferable to the image obtained with the older arrangement, because it permits measurement of the contact

angle at the actual "line" of triple-phase contact and eliminates sources of errors arising from the possibility that the edge of the test-particle is at a higher level than that of the surface at which contact, if any, is established. Fig. 7 shows the schematic arrangement of the elements of the bubble machine in the new plan.

The most important factor in the successful preparation of a specimen for testing in the bubble machine is cleanliness.

Mineral particles or metal particles which are to be tested with the machine are prepared in the following manner[15]:

A piece is selected for its purity and for lack of cracks and faults, of such size that it can be ground to the shape of a parallelopiped $\frac{1}{2}$x$\frac{1}{2}$x1 in. Two opposite surfaces in the long dimension must be ground flat and reasonably parallel. This first rough grinding is done on a cast-iron lap, using grade FF alundum (The Norton Company) or other similarly suitable grinding material, and water. After this, the subsequent polishing is confined to one of the surfaces only. The next step is to polish the surface on a canvas lap with alundum X (The Norton Company) and water. The final polish is obtained by using a velvet lap and levigated alumina or magnesia (depending on the hardness of the surface being polished) suspended in distilled water and kept in a glass container. This last stage is the most important. The fingers must not come in contact with the surface being polished nor with the lap, and the particle surface must be kept constantly under water. In addition, great care must be taken to avoid activation of some particle surfaces from salts originating from the other particle surfaces which have been previously polished on a given lap or from the metal of which the lap is made.

The ideal arrangement is to have a lap for copper minerals, another for lead minerals, and so on. Also, laps made of glass or of metals such as aluminum, which could not supply heavy metal ions, should be used for polishing sphalerite or other particle surfaces which may be activated by heavy-metal ions.

When the desired polish has been obtained, the surface is immediately washed with distilled water and then dropped into distilled water (tap water may contain heavy-metal ions and rust) contained in a glass dish the bottom of which is covered with several thicknesses of clean filter paper. Further handling of the particle is done with platinum-tipped forceps which have been previously cleaned by soaking in cleaning mixture, rinsing in tap water and distilled water, and finally have been burned to a red heat in an oxidizing flame. Holding the test particle under water with such cleaned forceps and with the polished surface down, the latter is rubbed gently on the clean filter paper at the bottom of the dish (to remove grinding mud from the polished surface) and then left immersed in the dish, polished surface up, and not disturbed until time for testing.

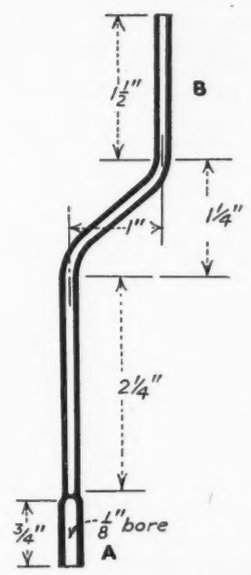


Fig. 5. . . . THE BUBBLE HOLDER. This is mounted on the microscope stage through a sleeve which is brazed onto the stage mechanism, at the point "D" shown in Fig. 4.

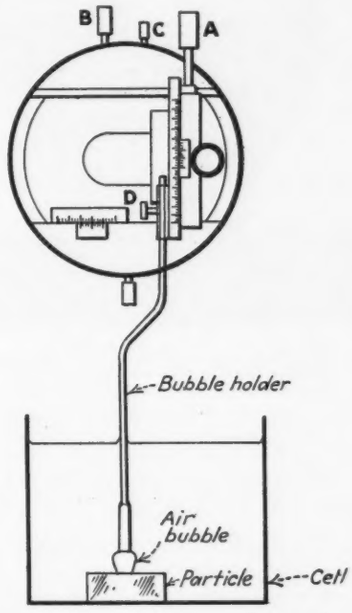
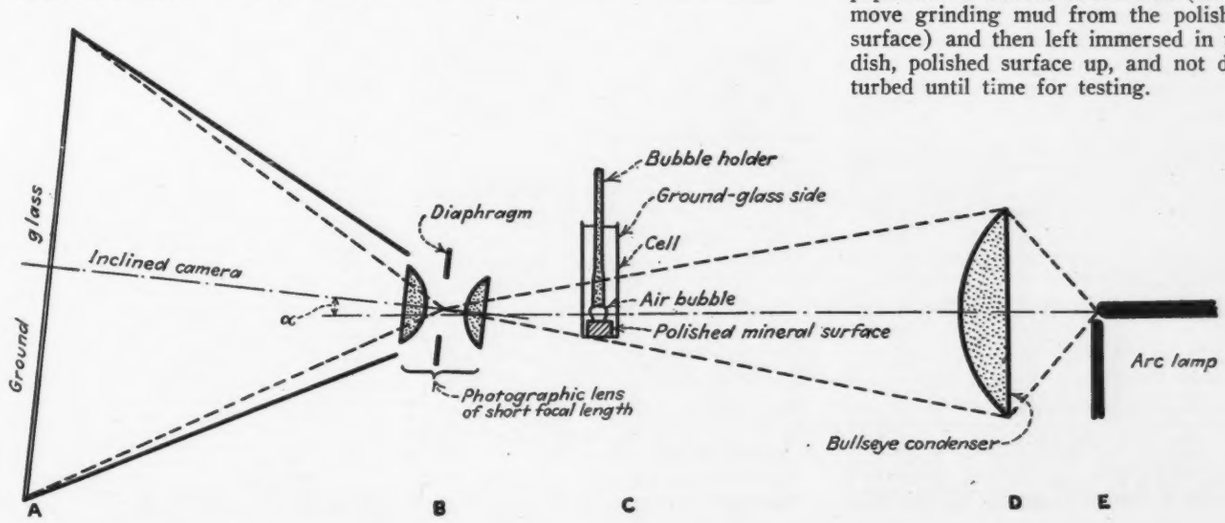


Fig. 6. . . . AN ASSEMBLY of the microscope stage (Fig. 4) with the bubble holder (Fig. 5) mounted on it and inserted in the cell, as in the course of a test. The letters are explained in Fig. 5

Fig. 7. . . . A SCHEMATIC ARRANGEMENT of the elements of the bubble machine. This, with the halftone illustration shown in Fig. 1 and the accompanying line drawings, gives an adequate idea of the construction of the machine and the optical principle involved. The dotted lines indicate the approximate course of the rays



A test of freedom from organic contaminants of collector type after the final polishing may be had by giving a second or so of opportunity for the polished surface, held horizontally in the air, to dry. If it does dry in part—that is, if the water film, instead of remaining spread out, draws together into drop—the surface is "grease" contaminated. The only exception to this statement yet found at Columbia is the mineral gilsonite, and it is only from such hydrocarbon minerals (graphite remains wet) that such drying is to be expected.

It is further necessary that particles after polishing be kept separate from others which might supply ions to activate them. To avoid such a difficulty, each polished particle should have its own separate container.

The cell, the bubble holder, and a medicine dropper with the tip curved back 180 deg., with which an air bubble or an oil globule is placed in the bubble holder, should be soaked in cleaning mixture (chromic acid solution) and then thoroughly rinsed in running tap water with a final rinse in distilled water.

First, the cell is rinsed with and then filled with the desired liquid. Then, holding the particle to be tested with the clean platinum-tipped forceps, it is brought up through a constantly changing air-water interface (the overflowing surface of water in the container). This insures against contamination (airborne grease will invariably adsorb at stagnant air-water interfaces). The particle is immediately immersed in the solution in the bubble-machine cell and moved back and forth vigorously for one minute (longer if necessary). Finally, the particle is placed, with the polished surface up, on the bottom of the cell at its center.

Clean surfaces in water should give a contact angle of 0 deg. If a surface gives a contact angle in clean water (note exception mentioned in a preceding paragraph) it indicates that it is not clean and it must be repolished (final polish only) until no contact angle is obtained in water. Sometimes, when no contact angle is obtained where one is expected, that result may be due to residual slime particles adhering to the surface[16] which have remained in spite of the rubbing against filter paper treatment. Repetition of this rubbing treatment usually removes these slime coatings.

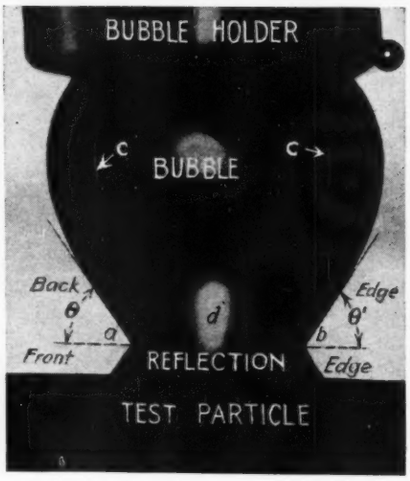


Fig. 8. . . . AN AIR BUBBLE in contact with a galena surface in a 1/40,000 solution of potassium ethyl xanthate, photographed within bakelite-glass cell. The contact angles usually measured are the angles θ and θ'. "C" and "d" are explained in footnote 17

The glass sides of the bubble-machine cell are then dried thoroughly, and the cell is placed on the bubble-machine cell stage, with the ground-glass side toward the source of light.

In operation, place the bubble holder in place in the sleeve of the microscopical mechanical stage so that the cup is below the surface of the liquid in the cell and form therein a bubble of air or a globule of oil of suitable size by means of the curved medicine dropper. By means of the vernier screw on the microscopical mechanical stage, *A* of Fig. 4, bring the bubble or globule down until the lower surface almost makes contact with the polished particle surface, at the same time watching the operation on the ground glass of the camera. By means of the rack and pinion on the camera, *h* of Fig. 1, focus the image of the bubble or globule on the ground-glass screen of the camera. Center the particle image on the ground glass of the camera and make the polished surface of the particle approximately level by making the proper adjustments with the cell stage (Fig. 2) as already explained. Center also the bubble or globule, if necessary, with vernier screw on the microscopical mechanical stage, *B*, of Fig. 4.

Press down the bubble or globule gently onto the particle surface by means of vernier screw (*A* of Fig. 4). Then raise it immediately to note whether there is any immediate contact or cling. Failing immediate contact, press down the bubble or globule on the surface as far as it is possible without losing the bubble or globule. Permit the air bubble or oil globule to remain pressed thusly against the polished surface for some definite time interval.[17] Then start raising the bubble or globule very slowly, watching the performance on the ground glass of the camera until the line of three-phase contact, *ab* of Fig. 8, just begins to contract. The ground glass of the camera is purposely ruled in squares, as previously stated, to facilitate the determination of this recession. Tap the cell stage gently until the bubble or globule comes to equilibrium. Measure the contact angles.

The contact angles to be measured are the angles θ and θ' of Fig. 8. Usually, a transparent protractor of suitable size is used. The protractor is placed on the ground glass of the camera with the origin at *a* and with the straight-edge along line *ab*. Any straight-edge then may be used to measure the angle. Another measurement is made at *b* and the two readings are averaged to give the contact angle.

FOOTNOTE REFERENCES

[1]Taggart, A. F.; Taylor, T. C.; and Ince, C. R.: "Experiments With Flotation Reagents." *Trans.* A.I.M.E. (1930) 87, Milling Methods, 285.

[2]Wark, I. W., and Cox, A. B.: "Principles of Flotation—An Experimental Study of the Effect of Xanthates on Contact Angles at Mineral Surfaces." *Trans.* A.I.M.E. (1934) 112, Rocky Mountain Fund Volume on Milling Methods, 189.

[3]Shepard, O. C.: "Bubble Attachment in Flotation." *Min. & Met.* (1932) 13, 282.

[4]del Giudice, G. R. M.: "Collection in Flotation." *E.&M.J.* (1934) 135, 213.

[5]*Ante.* Note 1.

[6]*Ante.* Note 2.

[7]Wark, I. W., and Cox, A. B.: "Principles of Flotation—II. An Experimental Study of the Influence of Cyanide, Alkalis, and Copper Sulphate on the Effect of Potassium Ethyl Xanthate at Mineral Surfaces." *Trans.* A.I.M.E. (1934) 112, Rocky Mountain Fund Volume on Milling Methods, 245.

[8]Wark, I. W., and Cox, A. B.: "Principles of Flotation—III. An Experimental Study of the Influence of Cyanide, Alkalis, and Copper Sulphate on the Effect of Sulphur-bearing Collectors at Mineral Surfaces." *Trans.* A.I.M.E. (1934) 112, Rocky Mountain Fund Volume on Milling Methods, 267.

[9]Wark, I. W., and Cox, A. B.: "Principles of Flotation—IV. An Experimental Study of the Influence of Sodium Sulphide, Alkalis, and Copper Sulphate on Effect of Xanthate at Mineral Surfaces." *Trans.* A.I.M.E. (1936), T.P. 659.

[10]Wark, I. W., and Cox, A. B.: *Jnl. Phys. Chem.* (1933) 37, 815.

[11]Wark, I. W., and Cox, A. B.: "The Physical Chemistry of Flotation—V. Flotation of Graphite and Sulphur by Collectors of the Xanthate Type and Its Bearing on the Theory of Adsorption." *Jnl. Phys. Chem.* (1935), 39, No. 4, 551.

[12]del Giudice, G. R. M.: "Study of Slime-coatings in Flotation." *Trans.* A.I.M.E. (1934) 112, Rocky Mountain Fund Volume on Milling Methods, 398.

[13]*Ante.* 1.

[14]*Ante.* 2.

[15]del Giudice, G. R. M.: "Microscopy in Flotation Research." *Trans.* A.I.M.E. (1934) 112, Rocky Mountain Fund Volume on Milling Methods, 424.

[16]*Ante.* 12.

[17]The time required for development of contact may be determined by watching the image on the ground glass of the camera. When contact occurs, the line of internal reflection of the bubble or globule (*c-c* of Fig. 8) which was previously continuous, "breaks" (*d*, of Fig. 8), and the part of the particle surface which has made contact will be seen through the air-water interface of the bubble or the oil-water interface of the globule if the latter is transparent. Experience at Columbia indicates that when contact does occur, it is usually established within one minute from the initial contact.

Another method for determining the time required for development of contact consists of watching with the unaided eye the area of the particle surface which is in contact with the bubble or globule. As long as there is no contact, that part of the particle surface which is covered by the bubble or globule cannot be seen. However, as soon as contact begins, the surface of the particle will become visible.

Drilling the Round

Better results will be obtained with men of limited experience if definite instructions are provided for the foremen and bosses

The following text was prepared with a view to developing greater uniformity of practice at the Fresnillo Company's Zacatecas unit

Reed E. Roberts

Superintendent Zacatecas Unit, The Fresnillo Company, Zacatecas, Zac.

DURING TWENTY YEARS of close observation of mining work in the various capacities of mucker, trammer, timberman, driller, shift boss, foreman, and superintendent, I have been impressed again and again with the woeful lack of organization as to methods and equipment in many mines during their development stages. To correct this, the first step is to imbue the minds of shift bosses and foremen with the idea of the desirability of using well-organized methods. Further, one must be certain at the outset that they understand and approve of the methods they are to use. Without their cooperation the task of getting the miners to work efficiently becomes difficult if not impossible. Many a boss will continue to do as the superintendent or instructor has outlined, but in a half-hearted manner, and he will therefore fail to obtain the desired results, perhaps solely because he does not agree with the methods as they have been explained to him. If he cannot be persuaded to see the benefits of such organization, the company will be better off without him. On the other hand, once the personnel have come to appreciate the advantages of using organized methods, they will carry on with a minimum of supervision and obtain the best results.

A determined effort should always be made to reduce costs to the level required by conditions and to avoid the detrimental effect of reducing wages and dismissing labor. In selecting equipment, moreover, so far as the management is concerned, the first cost should not alone be considered, but the service also that is to be rendered by it. Every successful company will concede that its success is in large part attributable to the equipment used. This being such a vital factor, it is surprising to see in so many mines the heterogeneous collection of machinery from which first-class results are looked for.

In drilling underground, the prime objective is to break the most ground for the least expenditure of time and money. The first step towards the attainment of this is to devise and pursue an efficient procedure in drilling. Drillers are usually recruited from men who have learned to drill in other mines where the formation is dissimilar, or, in even less favorable instances, they are merely employed and told to drill without being given proper instruction such as should be given in view of the different working conditions. In both instances, the result is a minimum footage at a maximum cost.

With an ordinary blackboard and forty-five minutes' instruction twice a week a crew of fifty men can be trained in a short time. The results will justify the expenditure. Usually, such instruction can be given by the foreman. In large mines, however, it will be profitable to appoint a special drilling instructor.

Accompanying drawings illustrate certain drilling rounds. They show the number of holes in each round, the depths and spacing of the holes, the dimensions of the openings, and other details. For the particular formation that one has to deal with, the rounds required can be selected. By following a system such as this the crew can be trained to a point where all that is necessary on the part of the boss is to instruct the drillers to drill designated rounds. In this way, a maximum footage will be obtained at a minimum cost, so far as the drilling alone is responsible for it.

Fig. 1 shows the result of an improperly drilled round. The angle at which the back holes were drilled has resulted in the irregular back shown. Such practice causes a tremendous overbreakage on blasting, and, further, necessitates keeping an extra supply of blocks and wedges on hand to fill up the extra space before attempting to tighten the column for drilling. Moreover, it takes double the time and requires the help of an extra man to complete the set-up.

The angle at which the lifters were driven, in Fig. 1, is so steep that it was impossible for the last 2 ft. of hole to break, owing to the excessive burden placed upon it. This, as seen, causes a high ridge to be left at the collar, which in turn makes it impossible to maintain the grade and necessitates drilling pop-holes before ties can be laid for the track. Worst of all, only 4 ft. were broken of a 6-ft. round, although air, steel, time, and the necessary explosive sufficient to break the latter footage were used. Assuming the costs of the foregoing to be air, $4; driller, $5; explosive, $5; muckers, $9; steel and machine, $0.50; supervision, $0.50, we have a total of $24, or $6 per foot. Had the full 6 ft. drilled been broken, a saving would have been made. Regardless of how good the driller may be who next drills this face, he will have to square it up before a maximum break can be obtained.

Rock formations differ with the mine. A round that will break well in one may not do so in another. Judgment has to be used in every one drilled. Some ground breaks easily—almost any kind of drilling breaks it—but it is just as important to drill such ground properly as the hardest rock encountered, for with few exceptions too much powder is used and the ground is shaken up until it must be timbered to make it secure; moreover, the overbreakage in many cases doubles the amount of muck

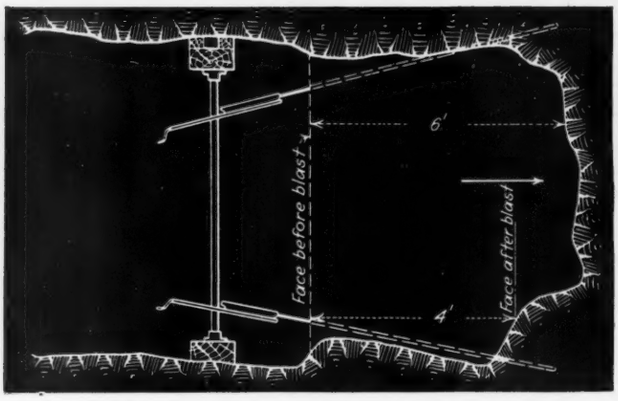


Fig. 1. This shows the result of an improperly drilled round. The irregular back is due to excessive pitch of back holes and lifters

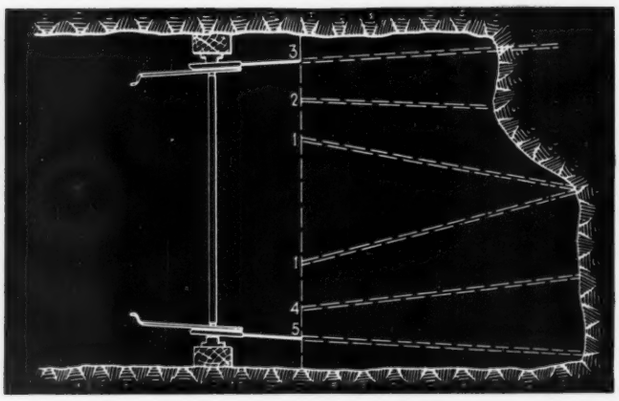


Fig. 2. The result of finishing a round with steel of different lengths is illustrated here. Hole 2 was too short to relieve No. 3 sufficiently

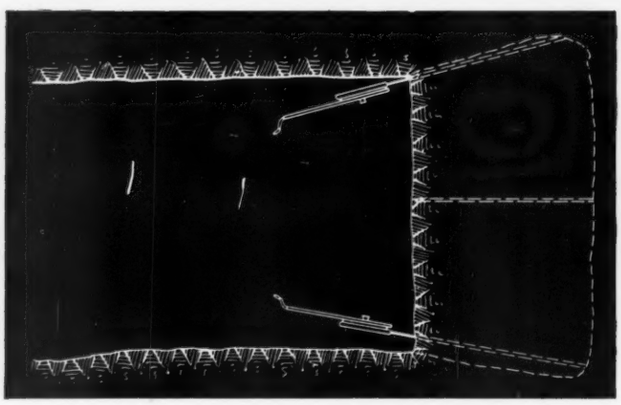


Fig. 3. The effect of excessive flare of the side holes is shown in this plan view. The result that these will give is excessive over breakage.

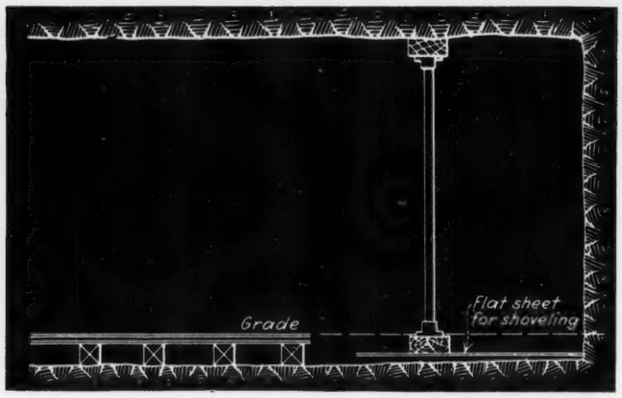


Fig. 4. Bottom should be broken at least 8 in. below grade. The track can always be brought up to grade by ballasting to the extent required

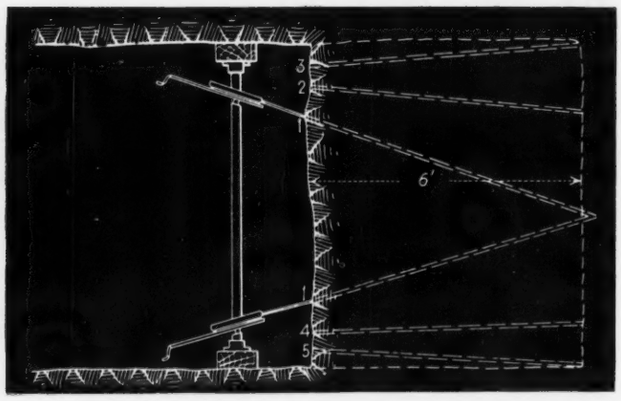


Fig. 5. In drilling cut holes, finishing steel should be a foot longer than other finishing steel, because of the greater pitch of the cut holes

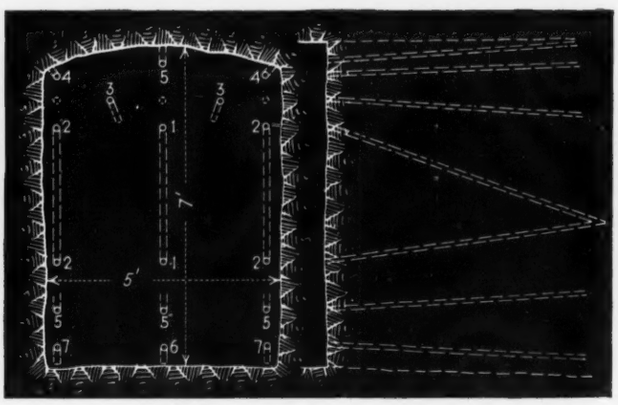


Fig. 6. A 17-hole round, in two views, for hard rock. Six V-cut holes are used. Modifications can be made, based on the way the ground breaks

that would have to be handled if broken properly. Mucking is one of the most expensive items in underground development and should be reduced to a minimum.

In setting up, the column should be placed 38 in. to 42 in. from the face to facilitate changing steel, inasmuch as all time consumed in changing steel cuts down the actual drilling time. The steel for drilling should be selected and placed conveniently, so that no time is lost in looking for the piece wanted for the next change. The driller should never drill so far with one piece of steel that the gage is lost, with the result that the next steel will not follow in the hole. The abrasive action of hard rock on a revolving steel is very great. This point is important, for to spend 30 minutes or more in drilling 4 ft. of a 6-ft. hole, and then lose the gage on the steel, often means taking 30 or 40 minutes in reaming the hole out sufficiently to allow the next steel to follow. Just as often, several pieces of steel are broken in the attempt, a great strain is put on the ratchets of the machine, and the hole may be lost completely.

In earlier days, when all drilling was done by hand, it was imperative that a miner should spend some time in studying the formation and take advantage of all slips, cracks, fissures, fractures, and the like, as the amount of drilling that could be done was limited. The

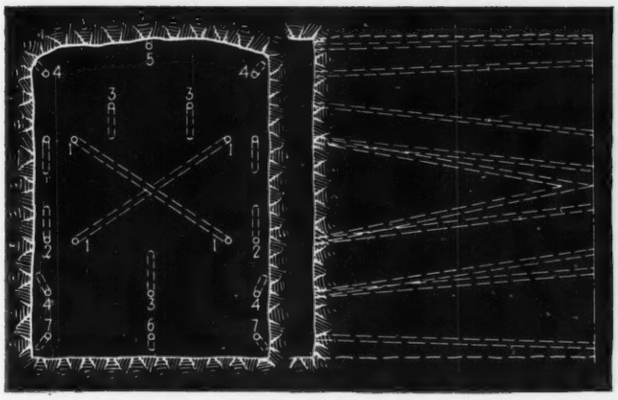


Fig. 7. Two views of a 19-hole round in which a pyramid cut is used. The drift is 5x7 ft. This round can be modified to suit conditions

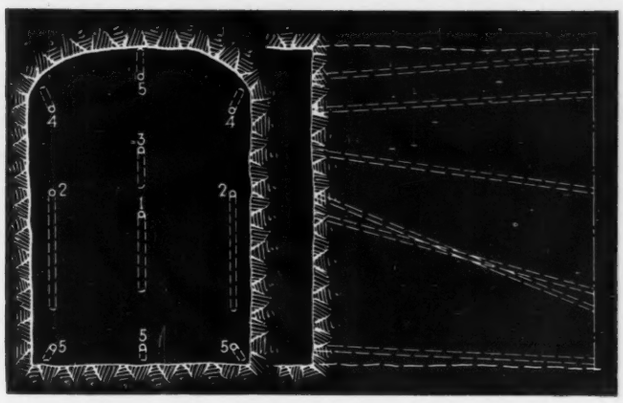


Fig. 10. A 10-hole round using three toe cuts, applicable in cases of moderately hard porphyry. The cross-sectional size of the drift is 5x7 ft.

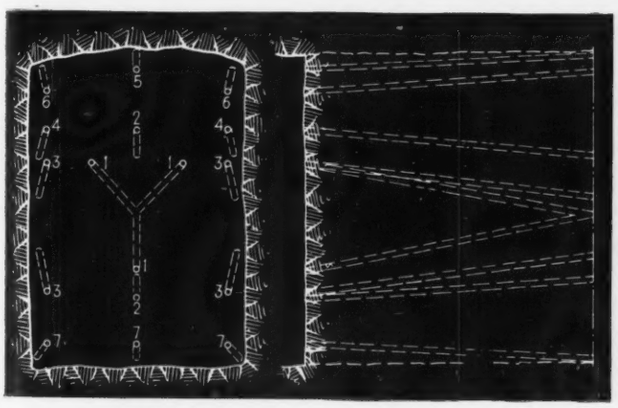


Fig. 8. In this 17-hole round a diamond cut is used. Care should be taken in drilling the cut holes. The drift is 5x7 ft. in size.

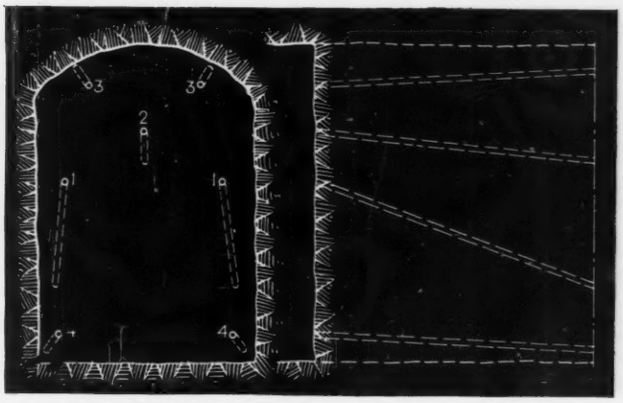


Fig. 11. This 7-hole round has been used successfully in a 5x7 ft. drift in highly cerussitized porphyry. The spacing of these holes is important

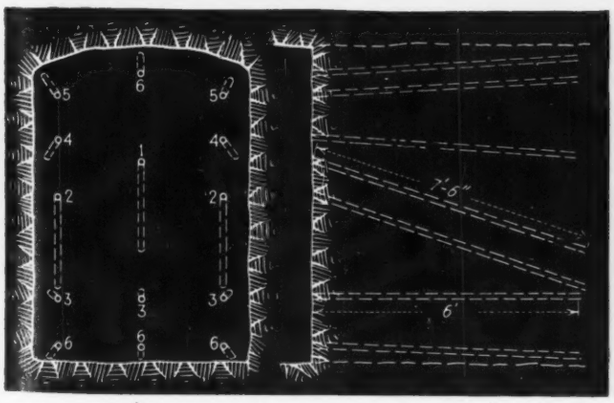


Fig. 9. A 14-hole round for some of the harder porphyries. Three toe cuts are used. In dimension the drift is 5x7 ft. in cross-section

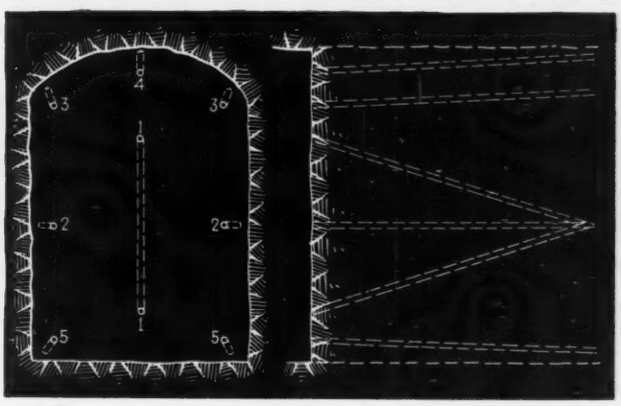


Fig. 12. This 9-hole round uses the center V-cut. Where timber is to be used the center back hole should be on a line with the other two

knowledge needed for this was indispensable to an old-time miner. However, in this day of modern rock drills not one miner in a hundred pays much attention to the formation. Out of this grows the need of using standard rounds that will break the maximum footage in any class of rock encountered. (The usual, but incorrect, procedure is to drill more holes and put in more powder.) Care should be taken in spacing the holes so that all have an equal burden.

All steel used for finishing should be of equal length. Fig. 2 shows the result of finishing a round with different lengths. The numbers indicate the rotation in which the holes are fired. Breast hole No. 2 is 1 ft. shorter than the other holes. It must break to relieve hole No. 3. But although it broke to bottom, it was not deep enough to relieve the back hole sufficiently to let it in turn break bottom, the result being the uneven face shown, giving the loss of 1 ft. per round. Figured in dollars and cents as before, this 1 ft. of ground was worth $5, which over a period of 30 days would amount to $150. If so much money is lost on every face in a mine each month, another system should be installed. One must also remember that holes should be flared as little as possible, at the same time maintaining the specified width of the draft. The greater the flare the harder it will be to break the ground.

A drill round having too much flare is shown in plan in Fig. 3. If it actually should break as planned, the overbreakage would be excessive, but generally it does not break. It is well to stand back in the drift 6 or 8 ft. from the crank of the machine and sight along the line of the drill. The distance the crank is from the wall will be approximately equal to the distance that the point of the steel is in the wall.

In drilling ground that does not have to be timbered care should be taken to keep the drift to the desired size by spacing the holes properly. The holes, including the lifters, should be kept as flat as possible. One should avoid flaring side holes and, above all, try to keep the bottom broken at least 8 in. below grade. Fig. 4 illustrates the advantages to be gained by using this method. When the muck has been cleaned up, all that one has to do is to slide the flat sheets forward, lay the ties, spike the rails, and ballast the track up to grade, which is much easier, cheaper, and quicker than digging for each tie until it is down to grade. The drainage ditch is at the same time provided, and in the future, when it becomes necessary to replace ties in the track, one will not have to do any blasting to get the ties down to grade.

In drilling ground that has to be timbered, drillers commonly break an opening that is much too small to permit the timber to be set in place. As a result, the timberman wastes some time picking down and, in many instances, drilling pop-shots to make room for the timber. More time may be spent in this manner than is required for putting the timber in place. Instead, such work should be avoided by drilling the hole right in the first place. The outside dimensions of the timber are, or should be, known, and the driller should so drill his round that when it has been blasted and the muck has been cleaned out, the timbers can quickly be placed.

Before going into details of certain rounds that are now to be described the importance of the cut holes used in a round must be stressed, for without the proper cut holes no round will break. More care should be taken in drilling them than is needed for any other holes, for success hinges entirely on this point. In some instances it is necessary to shoot the cut holes only, so that one may know how the cut has broken before attempting to shoot the rest of the round. The steel used for finishing these holes should always be 1 ft. longer than the other finishing steel, because of their steeper angle, as indicated in Fig. 5.

Inasmuch as the holes numbered 1 are on a steeper angle than holes 2, 3, 4, and 5, they must pull out the wedge cut before any of the other holes can break. Furthermore, as they seldom break bottom they should be drilled 6 in. past the face of the anticipated break, to insure an even face.

In drilling "V," diamond, and pyramid cuts, care should be taken to drill so that the ends of the holes will meet, as these holes must fire simultaneously. The average miner will contend that this is unnecessary and that if the holes are drilled within a few inches of the other, the concussion caused by one will fire the other. This is not so in dense ground free from fractures. In many cases one hole has been drilled within 2 in. of another and yet would fail to fire it. The procedure recommended is not as difficult as it would seem. With a little care in pointing the holes and the aid of a loading stick in determining the angles, one will be surprised to see how soon the holes can be crossed at the point with ease.

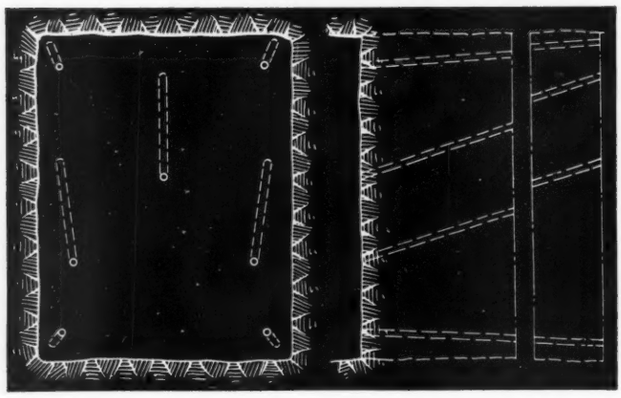


Fig. 13.
A 7-hole round using inverted toe cuts, for a 5x7-ft. drift. This can be used effectively in ground where it is hard to make a sludge

Fig. 6 shows a 17-hole round for hard rock, using three pair of "V"-cut holes. Judgment must be used in drilling such rounds. Where a hole can be omitted and the desired break obtained this should be done, or if it becomes necessary to add a hole to be sure of the break, it should be added. In some instances, it will be found that the two breast holes numbered 3 are insufficient to break clean. Should this be the case, one hole should be added, spaced as indicated by the broken circles shown near the top of the diagram.

One should note, where electric blasting caps are used, that the firing order of rounds is numbered. If safety fuse is used, the length for each hole should be such that the firing will follow the desired order as closely as possible. The results will be practically the same.

A 17-hole round, using a diamond cut, is illustrated in Fig. 8. Care should be taken in drilling this cut. (This advice also applies to the pyramid cut.) The machine should be as close to the wall as possible, as the wider the wedge at the collar of the hole, the easier it will be to get the desired break.

The three rounds shown in Figs. 6, 7, and 8 can be modified to break any ground encountered. These drawings show a 5 x 7-ft. drift in each case. In larger tunnels it will be found necessary at times to add relieving holes. It is the duty of the foreman or the shift boss to decide when they are needed.

Three toe cuts are used in the 14-hole round shown in Fig. 9. This round should be used in some of the harder porphyries. Care must be taken to use finishing steel 18 in. longer for the cut holes than for any other holes, because of the steep pitch. In slightly harder ground the center cut hole should be changed to the "V" cut.

Fig. 10 shows a 10-hole round using three toe cuts. This round is applicable in cases of moderately hard porphyry. If drilled according to this diagram, it should give a maximum breakage each time.

Fig. 11 shows a 7-hole round using two toe cuts. This round has been used successfully in highly cerussitized porphyry. The maximum depth of round broken in this type of ground is approximately 7.5 ft. The spacing of these holes is important, for by arching the back holes correctly, sufficient arch in the drift is obtained, thus avoiding the necessity of putting in timber. This ground never caves in large blocks, but in small flakes. If trimmed up weekly, very little timber is necessary for holding it up.

A 9-hole round is illustrated in Fig. 12 using the center "V" cut, and is an excellent round for soft porphyries. Where timber is to be used, back holes should be drilled on the same plane so as to square the back instead of arching it. Where no timber is to be used, it is good practice to arch the back, as it stands better and is safer.

The rounds shown can be adapted to any size of opening, by adding or omitting holes. One should remember that success hinges first on the cuts and second on proper spacing.

The rounds illustrated are also applicable to raises. In drilling, sufficient water should always be used to make a sludge in the bore soft enough to be thrown out by the stroke of the drill. Too much water is invariably used by drillers, which seriously retards progress in some mines. The packing nut should be kept tightened at all times on the water-valve stem, to prevent the machine vibration from opening it up. In this manner the water can be quickly gaged and an even flow maintained.

In some ground, such as shattered

quartzite and porous quartz, it is next to impossible to drill any holes with the least degree of pitch downward, due to the fact that the rock chips so coarsely that it is impossible to create a sludge which will be thrown out and free the drill. Fortunately, rock of this character is easily broken and does not require many holes. However, the lifters must pitch downward to a slight extent, and it is a good practice to use water very sparingly. The blowpipe should be kept at hand and the hole blown clean often enough to keep the drill free. Fig. 13, which is presented on the page opposite, shows an excellent round to use in this kind of ground.

At times it will be found advantageous to drill inverted cuts in rounds where the dip of the formation parallels the dip of the cut hole in an ordinary round, as rock always breaks better and a better shattering effect is obtained by drilling across the formation than with it.

Where two or three shifts are being worked during each 24-hour day in one heading, the depth of the rounds must be determined by the mucking facilities. In other words, no more ground should be broken than can be cleaned out in eight hours, so as to complete the drilling, blasting, and mucking each eight-hour cycle.

In an average mine there are several headings for each driller, in which case one good driller can keep two mucking crews going and have a clean face in which to drill at all times. By doing this many drillers will drill and break two rounds each day. By this method the management can soon determine just what each foot of ground should cost, and all work can be put on a footage basis, by paying so much a foot for drilling, so much for mucking, and allowing so much for explosives. This also creates an incentive for the men to attain a higher degree of efficiency. The greater their efficiency, the higher their remuneration. Probability is eliminated, better work is obtained, and the employee is more contented.

(To be continued in the July issue)

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Calcine Charger Uses Centrifugal Force

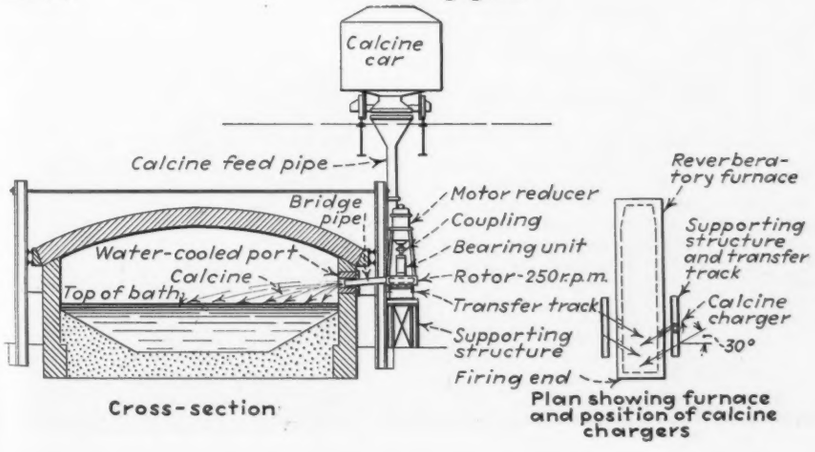
DURING the last decade, various calcine chargers have been designed and used. Recently one known as the Warnack charger, which is shown in the accompanying cut, has been developed, according to F. C. Torkelson, designing engineer for United States Smelting, Refining & Mining Company. Furnace and calcine car are shown in dot-and-dash lines and the charger is shown in full lines. The calcine is charged by using centrifugal force to throw it, much the same as with a fan, but no air enters the furnace with it.

The charger consists of a cast-iron housing, a cast-iron rotor, and a bridge pipe. Mounted on top of the charger is a motorized reducer driving the rotor at 250 r.p.m. The charger is mounted on wheels, so that it can be moved from one charging position to another. One charger is required on each side of a furnace.

The rotor capacity is governed in a small degree by its speed and its diameter. A 30-in. diameter rotor running at 250 r.p.m. will charge 12 tons of calcine in four minutes. Too much speed will throw the calcine too far into the furnace. Sufficient speed to overcome the furnace draft and to force the calcine into the bath is all that is required.

Practical tests with the device have shown that greatly increased capacity is had by using a larger rotor.

Advantages of the charger are: Marked decrease in dust going to the waste-heat boilers; no dust blow-back into the calcine car; no floating "islands" of calcine in the bath; even distribution of calcine on top of the bath; no air admitted to the furnace; no warping and sticking of the bridge pipe; low first cost, and repairs and upkeep negligible.



Zinc Cup Test for Cassiterite

IN BULLETIN NO. 2, Geological Survey of Uganda, 1935, W. C. Simmons describes a test for cassiterite that is very useful in the field and gives a means of confirming, with certain reservations given below, which of the grains in a heavy concentrate, obtained by panning a gravel or crushed rock, are cassiterite.

A tray or cup made by bending up a sheet of zinc is used to contain the concentrate, and enough dilute hydrochloric acid is poured on to cover it. After a few minutes the nascent hydrogen evolved from the zinc reduces the part of large cassiterite grains in contact with the zinc to metallic tin; and in the case of small grains coats them all over with a gray deposit of tin metal. The part of the larger grains which is so coated can be polished up to a shining metallic surface.

In practice, hydrochloric acid works best, though any other acid which will attack the zinc and yield hydrogen is stated to be effective, but the acid fruit juices are very slow and vinegar is slower still.

Tinstone as found in Uganda is variously colored, from colorless to white, yellow, buff, brown to black, and the change to opaque gray will serve to distinguish it at once from the iron ores, garnets, zircon, rutile, monazite, tantalite, and wolfram and other minerals commonly present in a concentrate, and if the tinstone grains are large enough they can be picked out; if they are small, their habit of gathering together on being shaken has been proved to be useful.

The metal used must yield nascent hydrogen when acted upon by acid and must be considerably more electro-positive than tin, so that though aluminum metal gives the tin coating somewhat more quickly than zinc, iron will not give the reaction.

There are certain pitfalls in the use of this test that should be avoided, as was realized in our laboratory when we received a pale buff amorphous mineral which was stated to be a peculiar kind of white cassiterite because it "tinned" in the zinc cup. The mineral was bismuth and in the zinc cup with acid assumed a black coat (with also a sponge of bismuth released owing to solution of the bismuth carbonate in the acid) which polishes up to a shining surface of metallic bismuth. This bismutite was occurring in an alluvial gold-yielding gravel in which cassiterite was known to be present at a point some distance upstream.

Further tests show that lead minerals give a coat of lead, and copper minerals of copper, but as the latter is red no confusion arises. Bismutotantalite rather reluctantly gives a bismuth coating.

Weepah Gold

Modern Methods and Equipment Make Possible the Operation of an Idle Mine

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FROM THE TIME of the discovery of the Weepah mines in 1904 by Frank Horton, up to the start of present operations, this mining property went through the viscissitudes common to the development of mines in the more or less isolated districts of the desert country. Returning to the property in 1927, Horton's son made a strike, and subsequently about $50,000 was taken from a prospect shaft. This discovery started a rush, which for a few weeks gave Weepah the semblance of a Nevada boom camp. As no other high-grade strikes were made, the excitement died down and the camp again became an almost forgotten spot in the Nevada desert.

A small mill was installed by the old company, and intermittent development continued until January, 1934, at which time the property was brought to the attention of the present operators. Thorough examinations conducted by H. C. Carlisle and H. W. Stotesbury, and later by E. J. Schrader, resulted in the mines, being taken over by what is now known as the Weepah Nevada Mining Company, of which Walter Haggerty is the managing director. Original plans called for the development of an underground system of mining, and work toward this objective continued until April, 1935. At this time W. Val DeCamp made a study of the property and recommended the open-pit, power-shovel method of mining now in use.

The operation was viewed throughout as a salvage job to be cleaned up as rapidly as possible within definite economic limits. The scale of operations determined upon was 250 tons per day, with estimated capital requirements of $170,650 to place the property on an operating basis. The estimates given in Table I were used as a basis for the undertaking.

Total capital eventually expended in equipping the property was about 15

OPEN PIT

AT THE

WEEPAH-NEVADA MINE

as it appeared on Dec. 1, 1935. Up to this time, approximately 62,000 cu.yd. of waste had been removed and 4,600 cu.yd. of ore produced. The equipment includes a 1¼-cu.yd. Lima gasoline shovel, four 3-cu.yd. dump trucks, a portable compressor and drills

THE SURFACE PLANT

as seen from the south end of the pit. At the left is the new dam for the mill tailings. In the center is the new 250-ton amalgamation-flotation plant with a truck dumping ore into the mill bin. At the right is the old shaft headframe and the mine buildings

per cent less than the expenditure shown in Table II, due chiefly to lower realized costs for the water-supply system and miscellaneous installations. Operating costs so far have been just slightly under the estimated costs.

The report by H. W. Stotesbury describes the deposit as follows:

"In a general way, the mineral values occur chiefly as gold in the free state, together with a small amount of silver, in a silicified gangue composed of quartz and altered country rock. The vein in which the values are found occupies a large fault, or shear zone, in schist and dips about 45 deg. to the west and cuts nearly at right angles across the bedding planes of the schist. There is little evidence of faulting except within the vein itself, which shows movement parallel to the walls, the vein material being crushed and sheared across the entire width of the vein. A section taken across the vein through the main shaft shows that it has a width varying from 40 to 80 ft. at that point. It has been exposed on the surface and to various depths up to 60 ft. by means of prospect shafts for a length along its strike of approximately 1,000 ft. Due to the soft nature of the greater part of the vein matter, the outcrop is not easily discernible, as it is obscured by surface detritus over the greater part of its extent. While the walls of the vein are not exposed in all the prospect shafts, all of them indicate widths of 20 to 30 ft., and over."

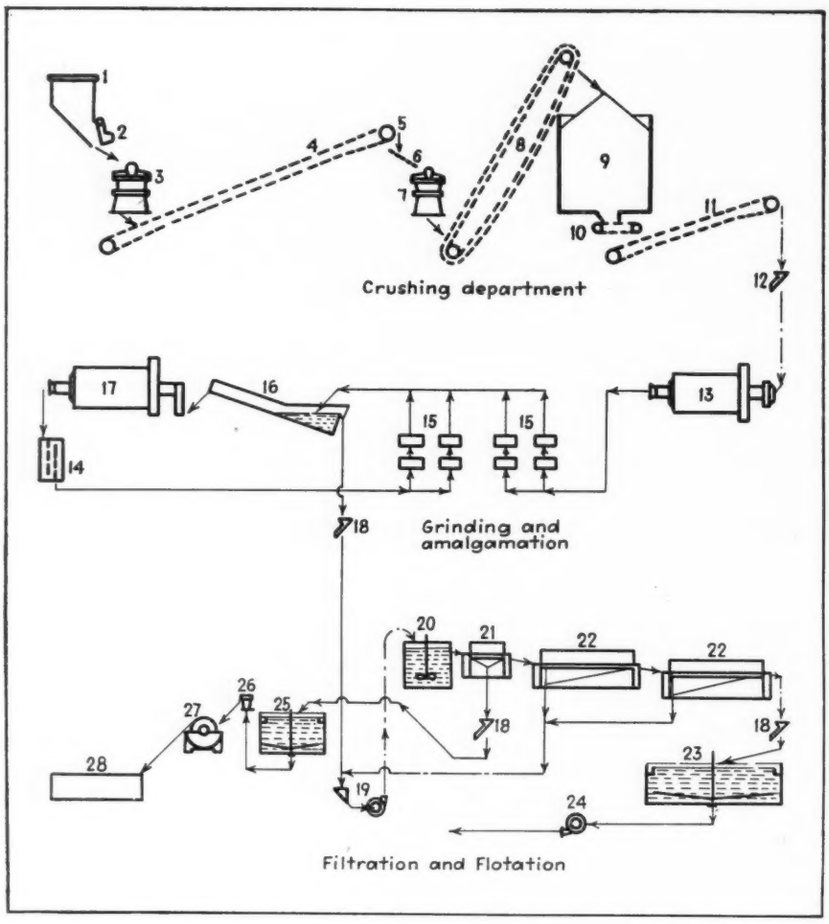
The illustration on page 303 shows development work done prior to the start of pit operations. Since that time little work has been done underground, the management having devoted its attention to pit development exclusively. This involved moving considerable overburden prior to starting milling operations, but development of the pit has now reached the stage where it is estimated that the ratio of stripping to ore will be about 1:1.

Until Dec. 1, 1935, about 62,000 cu.yd. of waste had been removed and 4,600 cu.yd. of ore produced. Some of the pit work is shown in one of the accompanying illustrations. Equipment consists of a 1¼-yd. Lima gasoline shovel; a bulldozer; a portable compressor; drills and accessories; and four 3-yd. dump trucks. During the period of pit development, two shovel crews were employed. For regular operation the mine crew includes a superintendent, a shovel operator, an oiler-mechanic, a powderman, two surface miners, a sampler, and an assayer and clerk on a half-time basis.

With this crew and equipment working day shift only, the required stripping is accomplished and sufficient ore is broken to maintain a full-time mill operating schedule of 250 tons per day. All ore and waste haulage is handled by the four Ford trucks on day shift. As the mill and waste dumps are situated at opposite ends of the pit, a comparatively short haul for either ore or waste results, and this also permits the loading of ore and waste into an alternate truck without confusion.

The company well is situated about 7 miles from the mine on the edge of a dry lake at an elevation about 1,400 ft. lower than the storage reservoir at the mine. The 100-ft. well supplies about 100 g.p.m., and the water is pumped to the mine through a 4-in. pipe in two stages, the booster pump being about midway between the well and the mine. The water supply has proved to be sufficient for all purposes at present.

Power is supplied by the Nevada-California Power Company, whose main line from Silver Peak to Millers, Nev., passes within 4½ miles of the mine. Construction consisted of 4½ miles of 55,000-volt line from the main line to the new substation installed between the mine and the well, and two 6,600-volt lines from the substation to the mine and well 4½ and 2½ miles in length, respectively. The current is stepped down to 440 volts by transformers at the mill, booster pump sta-



FLOWSHEET

of amalgamation-flotation plant of 250 tons' capacity erected by Weepah-Nevada Mining Company at Weepah, Nev. Construction was started Aug. 1, 1935, and milling work was begun on Oct. 8

LEGEND

1. 20-ton hopper and sledging grizzly
2. Finger gate
3. Traylor No. 12T gyratory crusher 2½" opening
4. 20" belt conveyor 180 ft.p.m. belt speed
5. 20" magnetic pulley
6. Rail grizzly, ⅝" opening
7. Traylor TY gyratory, size 2'-4"; ½" opening
8. Continuous bucket elevator 12"x6", 200 ft.p.m.
9. 24' dia. x 26' steel bin, 500 tons' live capacity
10. 20" Southwestern ore feeder
11. 16" belt conveyor
12. Dry (flap) sampler
13. 5'x10' Traylor rod mill, 19 r.p.m.
14. Clark-Todd amalgamator
15. Allen amalgamators
16. 8'x18'-4" Dorr Model F classifier
17. 5'x10' Traylor ball mill, 24.8 r.p.m.
18. Southwestern pulp samplers
19. 3" Wilfley sand pump, 870 r.p.m.
20. 8'x8' Southwestern conditioner
21. 4' Southwestern air flotation machine, cleaner
22. 16' Southwestern air flotation machines, roughers
23. 40-ft. Dorr thickener (tailings)
24. 3" Wilfley sand pump
25. 10'x8' thickener (concentrates)
26. No. 1 Dorrco diaphragm pump
27. 3'x4' Oliver drum filter
28. Concentrate dryer

tion, and well. Power cost is about 1.5 cents per kilowatt-hour on the basis of 520 hp. connected load and with an average monthly consumption of 400 continuous horsepower.

Metallurgical tests by the Southwestern Engineering Company and others indicated two possible methods of treatment — namely, amalgamation followed by cyanidation, and amalgamation followed by flotation. The former gave a better recovery, but entailed a greater first cost. As the estimated ore tonnage would have to be built up by future development if the property was to have a life that would warrant the more expensive plant, it was decided to install the less costly amalgamation-flotation treatment even though over-all recovery would be lower. Should results of future development call for the installation of cyanide treatment, a cyanidation unit will be added to treat the tailing from the amalgamation-flotation mill as well as tailing impounded in the interim.

Upon completion of mine sampling and metallurgical testing work, a contract was let to the Southwestern Engineering Company, of Los Angeles, Calif., for the design and construction of a 250-ton amalgamation-flotation mill. Specifications included new equipment throughout the plant, concrete foundations and floors, concrete thickener tanks, steel bins, and structural steel buildings covered with galvanized corrugated iron. Construction of the plant was started Aug. 1, 1935, and milling started Oct. 8, 1935. Operations and equipment used are explained in the accompanying flowsheet.

Ore is delivered to the receiving hopper by 3-cu.yd. dump trucks and discharged upon a rail grizzly with 12-in. openings. Undersize is fed to the primary crusher through a manually controlled finger gate, and the oversize is broken by hand. The 2½-in. crusher product goes via a 20-in. belt conveyor to a second rail grizzly, spaced ⅝ in., the oversize being reduced to about ½ in. by a secondary crusher. The crusher product and grizzly undersize are elevated by a continuous bucket belt elevator to a 500-ton fine-ore storage bin. Capacity of the crushing plant is from 60 to 70 tons per hour.

From the mill bin ore is drawn by a 20-in. belt ore feeder and discharged onto a 16-in. belt conveyor leading to the drum feeder of the rod mill. The mill product flows to four Allen amalgamators, and the amalgamator tailings go to the auxiliary feeder scoop of the Dorr classifier. Classifier rake sands make up the ball-mill feed. The ball-mill discharge flows to a Clark-Todd amalgamator, which is followed by four Allen amalgamators. Tailings from these machines join the rod-mill discharge at the classifier auxiliary scoop. The classifier overflow is pumped to the conditioner at the head of the flotation machines. Conditioned pulp goes to the flotation cleaner cell, where a finished concentrate is made, and the tailing flows successively to the primary rougher cell and the secondary roughter cell, which produces the final tailing. The concentrates from both rougher cells are pumped back to the conditioner tank.

Finished concentrate flows to a thickener, from which the underflow is pumped to the filter by a diaphragm pump. Dewatered concentrate is dried on pan driers, sacked, and shipped to the smelter. The flotation tailings go to a thickener for treatment, and thence to the tailing ponds, where additional water is recovered. Overflow water from the concentrate and tailing thickeners, as well as the water recovered from the two tailing ponds, is returned to the mill circuit. The foregoing account briefly outlines the present treatment. Some adjustments have been made during the breaking-in period for the following reasons:

First, a considerable difference existed between the stripped surface ores first to be mined and the under-

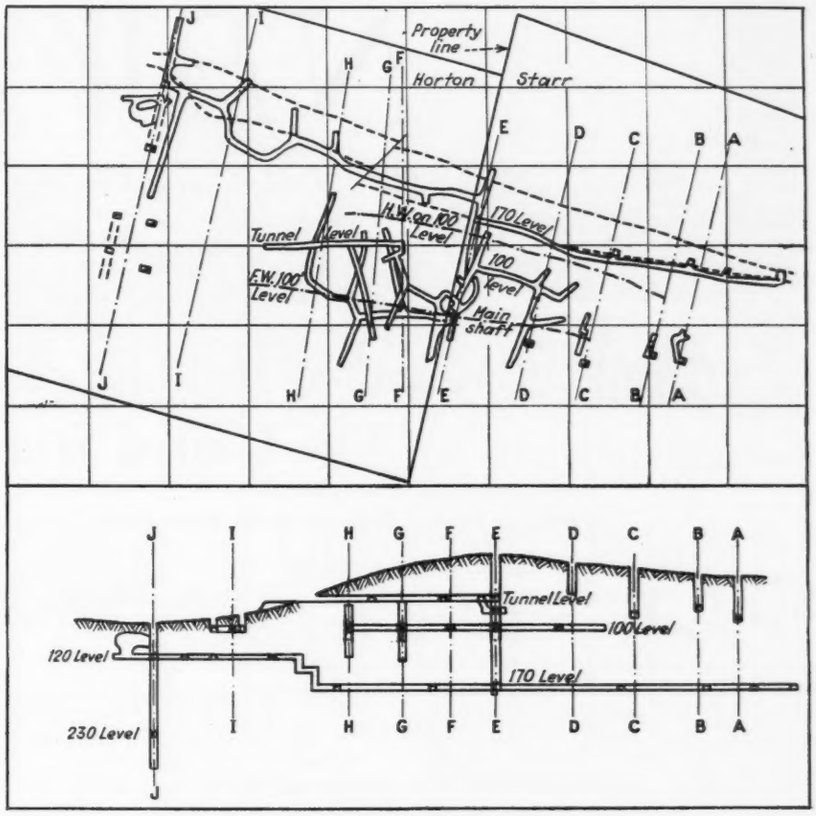
ground ores available for testing. The former carry seams of talc, which brought about a settling condition not anticipated. The muddy overflow from the tailing thickener had a detrimental effect on classification, and in general was troublesome in the water-supply system. As the tailings were to be impounded for possible future treatment, and as waste stripping from the mine had to be hauled to waste dumps, it was decided to use this material for building the tailing-pond dam. This entailed no additional cost for handling the waste material, and an adequate tailing disposal area was thus obtained. The two storage ponds, used alternately for receiving tailing and settling, are now in use. By drawing more heavily from the thickener underflow, a clear overflow can be maintained, while the required remainder of recovered water is obtained from the ponds.

The second difficulty arose from excessive agitation in the settling pool of the classifier. Reduction of the rake speed from twenty to sixteen strokes per minute did not eliminate the trouble. Ultimately, upon recommendation of the manufacturer, the rakes at the overflow end of the classifier were altered by cutting the end rake to 1 in. and each succeeding rake so that its depth was $\frac{1}{4}$ in. greater than the rake just below. This was continued until the regular rake depth of $4\frac{1}{2}$ in. was reached. Most of the undesirable agitation was thus removed and the required 100-mesh separation attained.

The rod- and ball-mill speeds at the start of operations were 21 and 29 r.p.m. respectively. The rod mill was changed to 19 r.p.m. with no loss in grinding efficiency and a reduction in power from 80.7 to 74.2 hp., and the ball-mill speed was reduced to 24.8 r.p.m. with a drop in power from 86.7 to 80.7 hp. Additional balls were added until the power reading showed 85 hp. and a much more uniform and finer grinding resulted. The type of grinding done by the rod mill, and the change resulting in the ball-mill circuit due to the classifier modification, the reduction in mill speed, and the greater ball load are shown in the accompanying tables.

As shown in the flowsheet, amalga-

(Continued on page 306)



UNDERGROUND WORKINGS

of Weepah-Nevada mine, showing the extent of the development work done prior to the start of the open-pit operations, since when little has been done underground. Above, a composite plan. Below, a longitudinal section

Table I—Ore Tonnage Estimates

Positive ore	134,000 tons @	$8.40 per ton
Probable ore	50,000 tons @	8.40 per ton
20 per cent dilution	36,800 tons @	2.00 per ton
	220,800 tons @	$7.33 per ton

Table II—Estimated Capital Expenditure

Mining equipment	$16,600
Milling plant	83 283
Power line and auxiliaries	12,534
Water supply (pumps, piping, and storage)	17,189
Camp	5,000
Preliminary waste stripping	21,053
Miscellaneous (laboratory, supplemental plant and construction)	15,000
Total	$170,650

Table III—Estimated Operating Costs

	Per Ton
Mining	$0.96
Milling	0.94
Administration, including royalties	0.79
Marketing	0.40
Miscellaneous	0.05
Total direct operating costs	$3.14

Table IV—Analyses Before and After Cutting Classifier Rakes and Slowing Grinding Mills

Mesh		Ball-mill Discharge Before Change		Ball-mill Discharge After Change	
Through	On	Per Cent Weight	Cumulative per Cent Weight	Per Cent Weight	Cumulative per Cent Weight
...	20	0.3	0.3	....	...
20	48	15.2	15.5	7.2	7.2
48	65	22.0	37.5	19.5	16.7
65	100	18.3	55.8	20.0	46.7
100	200	31.2	87.0	30.3	77.0
200	...	13.0	100.0	23.0	100.0

Mesh		Classifier Overflow Before Change		Classifier Overflow After Change	
Through	On	Per Cent Weight	Cumulative per Cent Weight	Per Cent Weight	Cumulative per Cent Weight
...	48	0.6	0.6	....	...
48	65	2.5	3.1	0.2	0.2
65	100	9.4	12.5	3.8	4.0
100	200	47.2	59.7	37.7	41.7
200	...	40.3	100.0	58.3	100.0

Table V—Average Screen Analyses of Mill Products

Mesh		Rod-mill Feed		Rod-mill Discharge		Classifier Rake Discharge			
Through	On	Per Cent Weight	Cumulative per Cent Weight	Per Cent Weight	Cumulative per Cent Weight	Mesh Through	Mesh On	Per Cent Weight	Cumulative per Cent Weight
...	$\frac{1}{4}$ in.	27.4	27.4	....	...	...	20	1.4	1.4
$\frac{1}{4}$ in.	20	49.7	77.1	1.4	1.4	20	48	40.2	41.6
20	48	8.3	85.4	18.7	20.1	48	65	25.7	67.3
48	65	2.6	88.0	14.7	34.8	65	100	14.7	82.0
65	100	2.6	90.6	13.9	48.7	100	200	13.3	95.3
100	200	5.0	95.6	28.3	77.0	200	...	4.7	100.0
200	...	4.4	100.0	23.0	100.0				

NEWS
OF THE INDUSTRY

China Is Added to the List of Silver Sellers to The United States

Buying of Chinese Reserves of the Metal Helps That Country's Currency Plans

SINCE the sudden drop in world silver prices last December, the United States Treasury has announced at various times agreements to purchase silver from Mexico, Canada, and, recently, China. In the past the Treasury has indicated that possibly some South American countries might be included, but no official announcement has been made of silver-buying agreements with any such country. Production of silver in the United States continues to increase. During the first quarter of this year about 14,759,000 oz. were produced. This compares with 11,510,000 during the last quarter of 1935.

China's departure from the silver standard in November last year was followed about a month later by the unexpected change in the silver-purchasing policy of the Treasury. This action created a period of pronounced weakness in silver, the world price dropping from 65 3/7c. on Dec. 7 to 44¾c., where it has remained during the last five months with only slight changes.

On Jan. 6 the Treasury Department announced that an agreement described as "mutually satisfactory" to both the United States and Mexico had resulted from silver stabilization conferences. Details of the agreement, however, were not made public. All silver bars now purchased from Mexico must be properly stamped, bearing the date of refining. After this agreement there followed the statement on March 4 that the Federal Reserve Bank of New York had been authorized, as fiscal agent to the United States, to purchase Canadian surplus silver production through the Bank of Canada "in amounts specified by the Treasury Department."

The traditional use of silver by the Chinese was recognized in the recent silver-purchase agreement with that country. On May 18 Chinese Ambassador Sao-Ke Alfred Sze and Secretary of the Treasury Henry Morgenthau announced an agreement on silver, satisfactory to China and the United States. Under the plan, the United States will purchase "substantial" amounts of Chinese silver at the world market quotation for the metal. The proceeds from the sale of silver to this country will be used by China for stabilizing its currency. China agrees to maintain at least a 25 per cent silver reserve against its note issues, and not to link its managed currency to any foreign monetary unit. The Chinese Government is to resume the coinage of silver and lift the ban on the use of pure silver for use in the arts and industry.

The Bank of China is opening a branch in New York to provide a medium for facilitating exchange operations. Total currency outstanding in China at present amounts to 790,000,000 yuan, according to Chinese monetary experts, and the silver reserve now is more than 50 per cent.

The measures adopted by the Chinese Government, in accordance with the decree of Nov. 3, 1935, are:

"1. It will continue to be the policy of the Government at all times to maintain adequate reserves against note issue consisting of gold, foreign exchange, and silver, the silver portion of the reserves to have a value equivalent to at least 25 per cent of the note circulation.

"2. For the purpose of completing the reform of the Chinese coinage system, the Government will issue silver coins of 50c. and $1 denominations.

"3. For the purpose of further strengthening the position of the Chinese currency, definite arrangements have been made to increase the gold and foreign exchange portion of the note issue reserve."

Secretary Morgenthau's statement, in part, follows:

"I feel confident that the monetary program being pursued by the National Government of China is not only along sound lines but constitutes an important step toward the desired goal of stability of world currencies.

"To supplement their efforts toward that objective and to cooperate with them in their program of monetary reform and currency stabilization and in accordance with our silver purchase policy, we have definitely indicated our willingness, under conditions mutually acceptable, to make purchases from the Central Bank of China of substantial amounts of silver and also to make available to the Central Bank of China, under conditions which safeguard the interests of both countries, dollar exchange for currency stabilization purposes."

More Gold

GOLD PRODUCTION of the world, exclusive of Russia, amounted to 6,501,000 oz. in the first quarter of the current year, against 5,717,000 oz. in the same period last year, an increase of 13.7 per cent, according to figures released by the American Bureau of Metal Statistics. In the absence of precise information, the Bureau is estimating Russia's production for 1936 at the same rate as last year, or at 460,000 oz. monthly. On this basis, total world production of gold in the first quarter of 1936 amounted to 7,881,000 oz.

The United States produced 313,000 oz. of gold in March, against 276,000 oz. in February and 291,000 oz. in January, a total of 880,000 oz. for the three months' period. In the Jan.-March period of 1935 this country was credited with 638,000 oz.

In the first quarter of 1936 Canada produced 832,000 oz., which compares with 691,000 oz. in the same time last year.

South Africa produced 2,749,000 oz. during the first quarter of 1936 against 2,614,000 oz. in the same period last year.

Iron Country

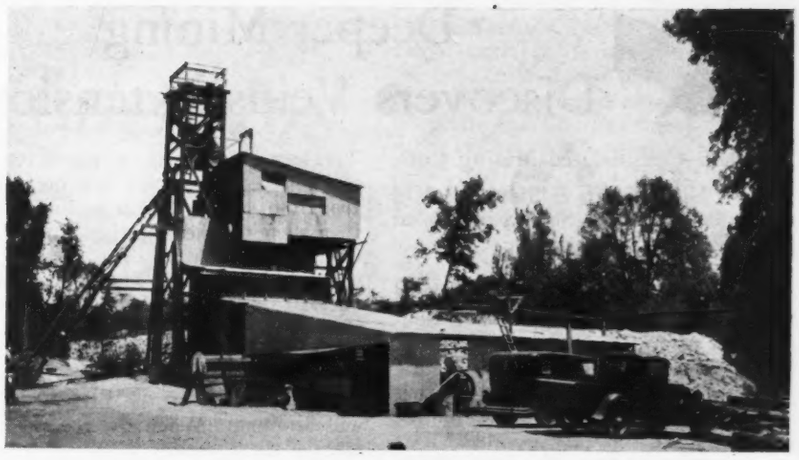
Iron-Ore Shipments Begin

SEASON OPENED sooner than expected—Many old mines start operations, and high production is expected during year

✦ Shipping of iron ore started the first week in May. Navigation opened when the steamer "Ishpeming," loaded with coal, entered the ship canal at 7:15 a.m. May 2, in a heavy snowstorm. Anchor ice, extending out into the bay 5 miles, slowed up the movement, but with favorable winds, keeping the ice from packing inshore, and tugs helping the boats through Whitefish Bay, the shipping season started about ten days earlier than expected. Plenty of ore was at the docks to care for the early arrivals, as the underground mines have been shipping ore since the middle of April.

✦ Many mines lying idle for several years have joined the ranks as producers. On the west end of the range these include the Arcturus of Oliver Iron Mining Company, and Pickands, Mather & Company is reopening the Danube, at Bovey, and the Bennett, at Keewatin. Butler Brothers are making no changes on the Missabe, but are reopening the Merritt mine, on the Cuyuna range. Near Buhl, the Interstate Iron Company is reopening the Grant mine, which has been idle and full of water since 1920. The Missabe Mountain and Minnewas pits of the Oliver Iron Mining Company, which were idle last year, are in production again. Most of the old operating mines have increased their shipping schedule about 25 per cent, which indicates a big year for the range. The big question mark to the employees is how long is this activity going to last? Everybody hopes to see it continue until snow flies next fall.

✦ Several pieces of new equipment have been received on the range and are now ready for the season's operation. Butler Brothers purchased two new Porter 0-6-0 switcher locomotives for the Harrison group of mines and has them in operation. At the Grant mine, at Buhl, a new 25-ton Link-Belt gas-engine-driven crane was placed in operation. At the Dale mine of Charleson Iron Mining Company, two 10-ton Clyde trucks which run in either direction with equal ease and require no turning around are used in the pit to supply ore to the new belt conveyor which carries the ore from pit to washing plant on surface. At the Bennett mine a new 40-ton Caterpillar tractor with bulldozer is cleaning off the ore ready to start shipping. Washing-plant improvements are completed and most of them have started the season's operations.



THE AUBURN-CHICAGO mine and mill near Penryn, Calif., has a capacity of 75 tons per day. The mill has a Titcomb ball mill, an Akin classifier, a concentrating table, and flotation cells

California

Silicosis Surcharge Became Effective June 1

LOWER RATES if safety measures are adopted by employers—Federal funds available for construction of débris dams for hydraulic mining

✦ The silicosis surcharge on compensation insurance rates in California, announced on May 4 in a decision by S. L. Carpenter, Jr., Insurance Commissioner, became effective June 1. Following are the 1936 rates, the surcharge included: Surface mining, $9.71; underground mining, $13.21; and ore milling, $4.24 per $100 of payroll. Under the new ruling employers may obtain reductions up to 50 per cent by adopting approved safety measures.

✦ According to a communication received from H. W. Klipstein, 1005 Mills Building, San Francisco, Roseklip Mines Company, controlled by Mr. Klipstein and associates, and not the Anglo American Mining Corporation, as previously reported, has acquired the Standard Consolidated property at Bodie, and has awarded the contract for the erection of a 250-ton cyanide mill to Western-Knapp Engineering Company, San Francisco.

✦ California-Osborn Mining Company, subsidiary of California-Engels Mining Company, 333 Montgomery St., San Francisco, has purchased under bond and lease the Morning Star mine, also known as the Kuhn mine, and the Gold Hill property, both in Calaveras County. Ore broken in these mines will be trucked to the mill the company is operating at its Belmont Osborn mine near Angels camp. A large Hardinge ball mill is being installed to increase the capacity of the mill to 250 tons. C. Stevenson is president of the company.

✦ President Roosevelt has signed the bill providing funds for the construction of débris dams in California necessary to bring about a revival of hydraulic mining on the American, Yuba, and the tributaries of the San Joaquin and Sacramento rivers. Hydraulic miners and operators are elated but apprehensive about irresponsible promoters already at work. The appropriation authorizes the expenditure of $4,600,000, but local operators must contribute a reasonable rental for storage space behind each dam. As soon as assurances have been received, work will start on investigations of foundations.

✦ On Standard Hill, in the Mojave area, where Jess Knight acquired recently the Liberty and Victory claims, a crew is at work on the property installing machinery preparatory to sinking the 120-ft. shaft to the 200-ft. level. A later report from Mojave indicates that Golden Queen Mining Company has acquired the Queen Esther mine, on the northeastern slope of Soledad Mountain, and plans early development of the property. W. C. Browning, general manager, directs operations at the Golden Queen.

✦ Development of the Sierra Alaska mine, near Pike, Sierra County, is being undertaken by Chicago, New York, and Los Angeles interests, according to an announcement by R. H. Travers, 433 South Spring St., Los Angeles. The mine is opened by a three-compartment shaft 680 ft. deep, which is to be deepened after unwatering operations have been completed.

✦ The annual report to the stockholders of the Lava Cap Gold Mining Corporation shows that the net income from production of 63,226 tons of ore during 1935 was $247,043.80. O. E. Schiffner is general manager.

Utah

Deeper Mining Discovers Veins Extensions

CHIEF Consolidated Mining Company finds new mineralized area on 1,000-ft. level—Shaft sinking at Frisco Silver Lead Mines

✦ Favorable developments in the Apex Standard property of the Chief Consolidated Mining Company have stimulated mining interest in the East Tintic district, near Eureka, Utah. In drifting toward an important objective on the 1,000-ft. level, a large mineralized area has been passed through, from which silver-gold ore is now being mined and shipped.

✦ Seventy men are now employed at the Park City Development Company's property, on work scattered from the 1,100 to the 1,300 level. Although the company is making no attempt to stope ore, shipments totaling 100 tons are made daily, all ore coming from development work. On the 1,300 level ore is being developed in three places, and the drift on the 1,100 level has recently broken into ore. Shipments contain silver, gold, lead, and zinc with 15 to 20 per cent of the net values in gold.

✦ At the King David property adjoining the Horn Silver mine, in the Frisco district, Beaver County, near Milford, the company is driving two headings from the 750 level of the shaft at a vertical depth of 1,550 ft. in the formation. At a point 2,400 ft. from the shaft, a drift is being advanced westerly, where a 22-ft. vein carrying some ore has been cut.

✦ In the adjoining Frisco Silver Lead Mines the company is sinking its shaft to the 300 level to obtain greater depth upon the orebody, from which shipments of high-grade silver-lead ore are being made.

✦ Operations are being conducted over a large area by the Lewiston Peak Mines Company at Mercur. At the Mercur Hill mine, the company has 70 men on company account and 100 leasers employed. All of the ore is being shipped to the Manning mill, several miles distant, for treatment. The company is drifting from the bottom of the 750 level in the Golden Gate shaft in the Mercur bed where a body of ore is being mined carrying from $5 to $12 a ton in gold. At the Manning plant, W. F. Snyder & Sons are planning to install Booth-Thompson flotation tables to increase production and improve recoveries.

✦ At Ophir, the Hidden Treasure mine is shipping 1,500 tons a month and employing 35 men. Utah Ophir Mines Company, just north of the Hidden Treasure, is driving a tunnel to get under a body of rich ore opened up from the surface in an incline tunnel. In advancing the tunnel, a large blind fissure was struck. The company is now sinking on this fissure in a blow-out—20 x 30 ft.—carrying high-grade pockets of ore. The tunnel has been advanced about 400 ft. At a point about 400 ft. farther, it is believed, the downward extension of the orebody above will be found. When the roads can be opened, the company plans to ship ore from its operations.

✦ Tintic Standard Mining Company has struck a good showing of lead-gold-silver-copper ore on the 1,450 level. The drift has now been advanced a distance of 200 ft. over the Eureka Lilly line. Plans are being made to connect the 1,450 with the 1,400 level of the Eureka Lilly, thus affording a connection through the Eureka Lilly shaft for better ventilation.

✦ At the Flagstaff Bonanza, also near Park City, shipments of ore, valued at about $14 a ton in gold, have been started. This ore is from the 350-ft. level of the new shaft. Some development work is being done in the old workings.

✦ New Park Mining Company, near Park City, has completed cleaning the Park-Galena tunnel and is starting a drift to explore the Park Galena fissure. The Star of Utah tunnel has been extended north until it recently struck the Wasatch fissure. The Mayflower tunnel is nearing the downward extension of the Park Galena orebodies, at a depth of 550 ft. below the stopes.

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Lalor Foundation for Research

ANNOUNCEMENT has been made of the incorporation of the Lalor Foundation for scientific research, to administer a bequest of $400,000 from the late Willard A. Lalor, a retired railway official and resident of Washington, D. C. Current income will be used for awards for support of purely scientific research and for fellowships in specific fields. Awards for the coming academic year will comprise five professorship and fellowship grants of $2,500 each, and are designed to recognize mature scholars of demonstrated ability and to afford them opportunity to conduct investigations under the freest possible conditions.

John Lalor, a brother of the donor of the bequest, was prominent in the early development of the mining industry in Montana, and when he died he left to his brother funds which now go into the Lalor Foundation. The Secretary of the Foundation is Dr. C. Lalor Burdick, E. I. du Pont de Nemours & Company, Wilmington, Del.

Weepah Gold

(Continued from page 303)

mation is confined to the grinding circuit. Such gold as is liberated by grinding in the rod mill may be amalgamated in the Allen units before entering the classifier, which also applies to the Clark-Todd unit and the Allen machines in the ball-mill-classifier circuit. As the sands from the classifier return to the ball mill, each succeeding pass through the mill liberates additional gold, thus permitting the maximum number of contacts in the amalgamation machines.

Flotation varies little from standard practice. Minor operating adjustments have been made from time to time to meet the changing ore conditions, particularly during periods when talcy slime is present. The addition of sodium silicate (0.5 lb. per ton) has aided materially in handling this material.

Careful dilution and alkalinity control have been found essential. In the test work better results were obtained when using Weepah water with pH 8.6 than when using Los Angeles water pH 7.6 to 7.8. It is believed that the better results were due to the presence of salts in the water rather than to higher alkalinity. Lime added to plant tailing as an aid to settling was found to be detrimental, as the amount of this reagent present in the reclaimed water had a depressing effect on the small amount of gold-bearing pyrite and arsenopyrite contained in the ore. Substitution of aluminum sulphate for lime has given better settling and has eliminated the trouble in the flotation plant. The regular reagents used and their points of addition are as follows: Xanthate (Pentasol), 0.07 lb.; 301 or 208 (Aerofloat), 0.07 lb.; pine oil or cresylic acid, 0.10 lb., all added at the conditioner, and sodium silicate, 0.50 lb. per ton of ore treated, added at the classifier overflow. Occasionally, it has been found advantageous to add a part of the reagents at the head of the secondary roughing machine.

At the time of writing this account, the plant has not been in operation sufficiently long to give detailed data of metallurgy and costs, but results so far are very close to those indicated by preliminary ore testing and anticipated in cost estimates. Operations have been carried on at a profit from the start of production. E. J. Schrader and W. Val DeCamp, consulting engineer and special consultant respectively, are largely responsible for the operating organization and plan of development. Mining operations are directed by the manager, J. C. Perkins, and D. L. Forrester is in charge of the mill.

NEWS FROM WASHINGTON

By Special Correspondent

MINING IS PRODUCTION—not interstate commerce. Wages, hours of work, and conditions of employment for miners are not subject to Federal regulation. These and other conclusions vital to the planning of mining executives are clearly fixed by the Supreme Court decision regarding the unconstitutionality of the Guffey Coal Act.

Either a change in the Constitution or a number of changes in the personnel of the Supreme bench must come before this situation will change. Political considerations will determine whether the constitutional issue is pressed vigorously in the campaign of this year. Changes in the membership of the Court are not likely in sufficient numbers to make a change in the fundamental philosophy of that tribunal at all soon.

Inflationary influences, many of them dressed in strange disguises, have been making holiday about Washington during recent weeks. The cumulative effects are hard to weigh; but it is quite evident that, in time, these factors will have further important influence on mining as well as in other industry. This is true, even since the Frazier-Lemke rout.

The direct inflationists of the Frazier-Lemke school put on a good show in the House of Representatives and developed a vote that would be surprising, or even disquieting, if anyone really believed that it reflected the serious intent of Congressmen. Politically, it was expedient for many members who do not believe in it to vote for this measure. Such votes were cast without hesitation in many cases because it was certain that the greenback type of inflation would not become law. As the issue quiets down this year, it does not die. It will be resuscitated in the next Congress by its ardent believers, with effects more determined by the result of November elections than by any economic considerations now measurable.

Price Regulation

The majority opinion found the price-fixing provisions so intimately interwoven with the labor provisions that the former fell with the latter, without regard to the constitutionality of price-fixing. Again the Court emphasizes that: Neither a commodity intended to move in interstate commerce nor one which has so moved is subject to Federal authority because of prospective or preceding interstate movement. Transactions before interstate commerce begins and those after interstate commerce has ceased do not come within Federal jurisdiction.

With respect to coal there is the immediate problem as to whether price-cutting, with subsequent wage-cutting, will follow this decision. The coal-mining industry has a marvelous opportunity to demonstrate its capacity for self-government in these particulars. Other mining industries will watch with interest and some concern. But at the moment these questions merely disturb political areas of Washington, and the peace of mind of the Alphabetic reformers. They give no comfort to those who wish Federal authority to be extended.

Speculation following this important court decision ran riot over the whole field of Alphabetic activity. Numerous forecasts were made as to what other agencies were thereby restricted or adjudicated out of existence. The immediate effect in changing executive policy of such agencies was, however, substantially zero. Each body, quite logically, continues its major activities in the hope that it can accomplish many of its objectives before explicitly ordered to quit by final Court findings. No more such rulings are expected from the Court until fall. No further changes in administrative policy appear at this time to be likely, in the Social Security or other reform agencies now operating.

Chinese Silver

AGREEMENT on Chinese silver policy was reached in Washington during May, the result of negotiations between the special commission of the Chinese government and Secretary of the Treasury Morgenthau. Stabilized trade and happier governmental relations are expected.

The buying of silver in China by the United States Treasury will *not* significantly affect the Government policy on the price to be paid domestic silver producers.

Every political weathervane points to a continuance through 1936 of the present price level for newly mined silver. To lower this price would offend Western industry and, more importantly, Western politicians. To raise the price would offend Eastern groups. To stand pat is expedient and offends no one in any direction.

Prospectors' Aid

Amusing, yet serious in implication, is the bill introduced by Representative Scrugham, of Nevada, which would provide Federal aid to the unemployed by making them mineral prospectors on the public lands. Washington imagines the pleasure with which the director of the Geological Survey would proceed if the provision in the original Scrugham bill were to be enacted. Under this provision of the bill the director would be instructed:

". . . to provide for employing citizens of the United States who are unemployed, in the discovery and development of the mineral resources of the public lands of the United States, and to provide for furnishing the persons so employed with a cash allowance of $1 per day and subsistence at the rate of $1 per day, and such clothing, medical attendance, and hospitalization as may be necessary, during the period they are so employed, and, in his discretion, to provide for the transportation of such persons to the places of employment."

Under the original form of bill, subsequently somewhat modified, half of the net proceeds derived from production based on such prospectors' discoveries wolud be placed in the United States Treasury. Even the most optimistic comments about Washington fail to indicate an anticipated income from this source equal to the cost of maintaining possible staffs of prospectors.

Budgetary Influences

Congress' willingness to increase the public debt by six billion dollars during the next fiscal year is a more certain and pressing factor of inflationary character. Unbalancers of the budget are, in fact, but poorly disguised inflationists, and the President belongs to this lodge. In fact, he wears the most ornamented of the spending uniforms of the order.

Less evident but perhaps most imminent in its inflationary influence is the question of international exchange and revaluation of currencies. The franc, bellwether of the gold flock, has been under such pressure as to make drastic steps essential by French leaders. What combination of gold embargo and revaluation will ultimately function remains problematic, and cannot be de-

termined even by French leaders soon. But their problem is political and compelling, much as the dollar devaluation problem of Washington two years ago.

As the franc falls the pressure on the pound will be almost irresistible and the political commotion will echo loudly in Washington. Well-informed observers of the Capital are, however, almost unanimous in forecasting that Roosevelt will not further reduce the gold value of the dollar, at least until after November elections.

Generally speaking, Washington expects a stone-wall opposition to greenbacks, but a continued spending, an acceptance of higher values for equities, a mild credit inflation, and unremitting pressure of Government for continued low-cost of money. Working in the latter direction is the Treasury's desire for further credits at low interest rates, as well as sure knowledge of widespread personal distress if tax and interest rates again get out of line with commodity values.

Perhaps most deeply disguised, and consequently most dangerous, of all inflationary factors is the Open Market Committee's manipulation of Government securities by its own support of the market. Critics, of course, explain that the Government can do this even if it does not permit any other business agency to attempt it under present laws regulating financial transactions.

Price for Power

No governmental agency exists with authority to place a price on the power to be generated at government-owned dams now under construction. Even would-be users cannot be told by anyone as to the cost or conditions of use under which they might arrange to employ some of the energy so generated. This matter has become of pressing interest, and the President undertook during May to force through Congress, before June adjournment, some provision which might be utilized this year as a step toward contracts for Bonneville power. That enterprise, from which energy may be available in the fall of next year, is deeply involved in a controversy between the numerous commercial and political interests of Oregon and Washington.

Washington State interests would like to have power from Bonneville averaged in with that in prospect from Grand Coulee, thus lowering the cost at the latter and making more nearly possible the sale of some of the energy from the upper Columbia. Portland interests naturally oppose such averaging up of the cost of their project, rightly fearing that the tide-water supply of power near the Portland harbor might, through any such composite calculation, become too costly a product to become readily marketable.

Pressure also continues for the readjustment of power prices at Boulder Dam. Waiver of some of the terms of the original contracts for use of that energy are likely. Power rates believed reasonable a few years ago, when this project was undertaken under the designation "Hoover Dam," are now as much out of date as a Model T Ford.

Tin-Scrap Gesture

SECRETARY OF STATE HULL, in late May, is asking interested industry about the tin-plate scrap situation. This move is made as a part of his work as agent of National Munitions Control Board. (See *E. & M. J.*, May, p. 256).

This and other actions are, in effect, but gestures. They relate to tin-plate scrap as narrowly defined by law and by the Board. They do not, however, significantly change any of the conditions affecting the supply of secondary tin.

The bulk of tin exports which would be a factor are in bearing-metal and other alloy scrap, and in old auto radiators and similar material. Those items are not subject to regulation under the law. As a means of control of strategic mineral supply the present law is full of holes.

Mining and mineral interests that may be concerned with the projects will unquestionably find that political influence is more effective than any amount of economic or social argument. The President believes in cheap power and will exert his influence toward its supply; but even this important factor will not be sufficient to disguise large operating deficits at the new Federal power projects if the rates for current are made too low.

Washington does not believe that even next spring Congress will be quite ready to establish either a Mississippi Valley Authority or a Columbia River Authority imitating TVA. That yardstick is yet too little proved politically to permit successful copies to be designed by the Congressional tailors. All of these projects remain, however, as legislation needing to be watched next year. In the meantime, Federal pressure for cheaper power supply to the general users continues. Cheaper power for industry would be welcome, if a convenient accessory; but is not an important primary objective of the Administration.

Fertilizer Minerals

Soil rebuilding with lime, limestone, gypsum, and with various types of fertilizer minerals has been adopted as an important part of the program of AAA in its present incarnation. For much of the territory where soil depletion has occurred by vigorous cropping the Government proposes to pay farmers for improving the fertility of the soil. The allowances offered under the new rules of AAA are about equal to half of the cost of the commercial fertilizer or mineral materials as delivered to the farmer.

It is estimated by the leaders of the fertilizer industry that these efforts of Uncle Sam to prevent soil depletion will stimulate purchase of many hundreds of thousands of tons of plant food. However, these allowances do not apply to the fertilizer used for actual crop production. They go merely to the farmer who is rebuilding the soil by green manure, or fallow-land treatment. In the long run they will contribute an increase in productivity per acre, but not immediately, because of these restrictions.

Northwest Minerals

To stimulate new mineral-using industries, many projects have been under study in the North Pacific Coast states. One such project has resulted in an extended report by Edwin T. Hodge, consulting geologist, which is titled "Available Raw Materials for a Pacific Coast Iron Industry." Though of limited interest in some parts, this report has very general value for mineral-using industries in presenting a detailed and authoritative summary of certain mineral deposits, not alone iron ore, and it includes careful estimates of cost of these various mineral products, fuels, fluxes, refractories, and other similar materials.

One of the more interesting parts of this information is the following summary, which estimates the cost of raw material supplies, laid down in Portland, for a variety of materials of interest in connection with the iron-ore study and research:

Iron ore, 60 per cent metallic iron, bessemer grade, a ton	$4.50
Coke, 81 per cent fixed carbon, a ton	6.50
Limestone, 90 per cent $CaCO_3$, a ton	2.50
Dolomite, raw, a ton	3.75
Dolomite, calcined, a ton	7.50
Magnesite, raw, a ton	7.00
Magnesite, calcined, a ton	9.00
Silica rock, a ton	6.00
Chromite, 45 per cent Cr_2O_3, a ton	10.00
Manganese, 48-50 per cent Mn, a unit	0.17

Industrial executives interested in utilizing the results of this general investigation should communicate with the North Pacific Division of the Corps of Engineers, United States Army, Portland, Oregon.

Nevada

Old Mines Being Examined at Aurora

OPHIR silver properties prepared for operations—Eastern Exploration ships ore to Garfield smelter

✦ Mines in one of Nevada's earliest bonanza camps, Aurora, are being sampled for Walter E. Trent and associates, under the direction of James Garnier, mine manager for the group and in charge of the rich Middle Buttes mine, near Mojave, Calif., owned by the Trent association. Trent also is preparing to reopen the old Ophir silver mine, some 60 miles north of Tonopah in Nye County.

✦ Eastern Exploration Company, subsidiary of Calumet & Hecla Consolidated Copper, conducting extensive work under option agreement on properties of the Goldfield Consolidated Mines, and Goldfield Deep Mines, at Goldfield, is reported to have shipped 15 carloads of ore to the Garfield smelter of the A. S. & R. Co. in Utah, ranging in value from $60 to $400 gold per ton. The option agreement with Goldfield Consolidated Mines, filed with the San Francisco Mining Exchange, provides for a total purchase price of $500,000 for the Consolidated properties, with graduated royalties applying on the purchase price and $150,000 to be paid by March 1, 1937. Augustus Locke heads the engineering staff of Eastern Exploration Company.

✦ Equipment for a 150-ton cyanide mill has been delivered to the Buckhorn mine in Eureka County, by the Pardners Mines Corporation, operating under lease and option. Charles Mayotte is superintendent and estimates the reserve at 100,000 tons of ore of mill grade. The mine was opened by the Wingfield group around 1910, when a 300-ton cyanide mill was built at the mine and power was supplied by an 800-hp. diesel-powered electric plant at Beowawe, 30 miles distant.

✦ At the annual stockholders' meeting of the Como Mines Company, held May 22 at the main office at Dayton, Nev., New York brokers now having administrative control were said to have failed to muster a quorum of shares and the meeting was adjourned for a month. The 350-ton flotation mill was said to have been operating for some time at less than half capacity. Reports indicated that at next month's meeting the project may again come under the former management.

✦ Mine equipment is being provided at the Wild Rose gold property, 12 miles east from Dayton and near the north end of the Como Mountain range. The property, opened last year by D. F. Meiklejohn, has produced high-grade ore and was recently optioned to John C. Higgins and associates. Work is directed by Albert Burch of Medford, Ore.

✦ Piermont Mines Company, resuming operation of an old silver-gold producer at Aurum, eastern White Pine County, has reconditioned its 75-ton flotation mill, providing some new equipment, after a shutdown of several years. P. L. Anderson has been made superintendent.

✦ Following approval by the federal district court of plans to reorganize and refinance the Nevada State Gold Mines, Inc., formerly the Seven Troughs Gold Mines Company, the property at Seven Troughs in Pershing County, it is announced, will be opened to greater depth, the 775-ft. Tyler shaft will be sunk 500 ft. deeper, and the 350-ton Coalition mill may be reconditioned for use as the main treatment plant of the company. Thomas F. Cole, now living at Pasadena, Calif., is head of the corporation.

✦ A large area at Manhattan, Nye County, embracing large surface deposits of gold-bearing schist, has been acquired under option by an Eastern group and is being sampled with the aid of a 100-ton mill under direction of George H. Garrey, who has offices in Philadelphia and Denver. Garrey formerly was consulting engineer for Tonopah companies.

Colorado

Expansion at Climax

LARGEST producer of molybdenum will increase production—Court decision stops dumping of tailings into streams

✦ Climax Molybdenum Company, at Climax, Colo., has under way a program of expansion. The company will increase milling capacity to 10,000 tons of ore per day; a new crushing plant is to be erected; a new 5,000-cu.ft. compressor will be installed; and the construction program will include a new hospital, more homes for employees, and a recreation hall. A new water system will also be installed.

✦ A court decision against the practice of dumping mill tailings into the streams in the State has resulted in closing several mills in the Idaho Springs and Central City districts. It is hoped this problem between farmers and mine operators will soon be solved. Meanwhile, more time is given to mine development, repairs, and installation of new equipment.

✦ The Improved Milling, Mining & Refining Company is converting the old radium plant at 1055 Tejon St., Denver, into a general milling, smelting, and refining plant. A Becker smelter, an oil-burning unit, will be installed for smelting concentrates, and McDonald flotation cells will be used in the mill. L. E. Terry is president of the company, A. C. McDonald, mine and mill engineer, Lindsey Becker, chief metallurgist, and Edward Williams, assayer and chemist.

✦ Nancy Smith mine, on Griffith Mountain, in the Capital Prize-Centennial mineral area, has been taken over by C. E. Cress and associates. The property is now being rehabilitated and operations are planned to start soon.

✦ A new mill to treat gold-silver ore is being built on the Emma Property of the Modern Gold Mines Company, at Dunton, Colo. Oscar Fisher is in charge of operations.

●

Flotation Machine Patent Not Infringed

An important decision relating to flotation machines has been rendered in the United States District Court at Denver, Colo., in the case of Joseph P. Ruth, Jr., vs. Shenandoah-Dives Mining Company. Similar suits brought by the plaintiff against Climax Molybdenum Company, and London Gold Mining Company and London Mill, Inc., were by agreement consolidated for trial.

The court found that flotation machines used by Shenandoah-Dives at Silverton, Colo., under Minerals Separation patents "did not, have not and do not now infringe patent No. 1,277,750 or any of the claims thereof." The patent in question is the so-called Pearce patent granted Sept. 3, 1918, and owned by the plaintiff. Claim 5 of the patent was found invalid and void for want of novelty and invention.

The plaintiff had previously effected a settlement with some other minng companies, and had also sustained a suit in the local District Court and Circuit Court of Appeals against Stearns-Roger Manufacturing Company, Denver, for infringement in building the machines used by the defendants. Vital evidence presented by the latter in the current case resulted in reversing the decision in the other courts.

Arizona

New Shaft Started at Copper Queen

WILL be sunk to 1,400 ft. and have three compartments—New mills under construction in Arizona

✦ Copper Queen Branch of Phelps Dodge (Arizona) is starting a three-compartment shaft on its property between Don Luis and Lowell, to be known as the Galena Shaft. The 1,400-ft. shaft is to be used for prospecting the ground approximately one mile southwest of the Campbell shaft and one mile east of the Cole shaft. Each compartment will be 4 ft. 6 in. by 5 ft. 6 in.

✦ Arizona Magma Mining, Chloride, plans construction of a 100-ton milling unit to handle increased production from the mine. The present 50-ton mill will be used for custom ores. A. C. Dundas is mill superintendent.

✦ Idaho Consolidated Mines has been formed to develop a property near Congress Junction, according to W. O. Woodbury, of Prescott. Surface ore will be mined by open pit and milled in a 25-ton amalgamation and flotation unit while a shaft is being sunk to the 600 level.

✦ The Roy Troxel claims, near Florence, have been acquired by Young and Conley, of St. Paul. Development work at the property is under the direction of C. H. Ames.

✦ The Eagle mine, at Signal, is to be equipped with a 50-ton flotation mill following deepening of the shaft from 100 to 300 ft.

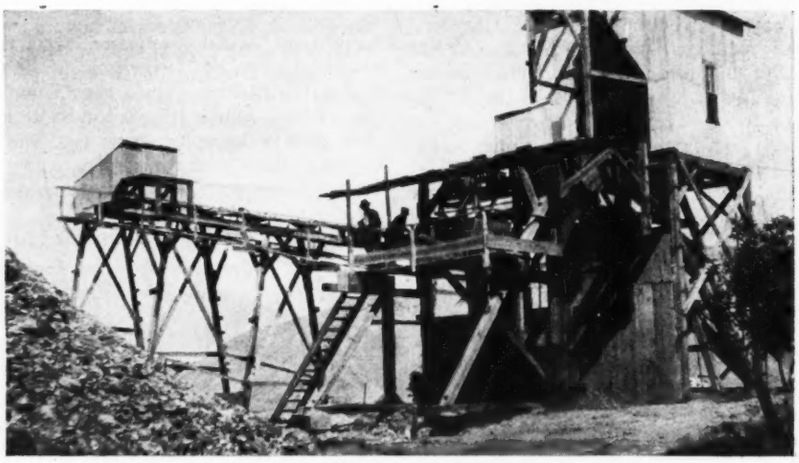
✦ Fortuna mine, 30 miles southeast of Yuma, will be reopened by Kenneth Holmes and E. A. Nicholson to supply additional ore for their mill at the Cargo Muchacho mine on the California side of the Colorado River.

✦ Meier Placers, Ash Canyon, near Hereford, are operating with power shovel, screen, and Ainlay bowl classifiers. An RFC loan supplied funds for initial operation.

✦ Fortunate Fields Mining has been granted an RFC loan for further development of its property, 14 miles from Aguila, Maricopa County. The property, under the management of F. A. Almstead, has been opened to the 300 level and equipped with a 10-ton stamp, 50-ton mill.

✦ Columbia Metal Mines is constructing a 500-ton mill at the mine in the Copper Basin district near Prescott. A jig and a corduroy table are to be used in the grinding circuit between the ball mill and classifier to recover coarse gold. Classifier overflow is to be floated. The oxidized ore is to be mined by dragline scraper and glory-hole methods. Charles H. Dunning, of Phoenix, is vice-president and general manager, and Fred D. Schemmer, of Prescott, is mine superintendent.

✦ Development of the Clays, or Two Friends mine, 2 miles north of Arivaca, has been started by H. M. Crowther, of Los Angeles. A 250-ft., two-compartment shaft is being sunk. The completion of the shaft is to be followed by 400 ft. of crosscutting.



SHAKER SCREEN AND PICKING BELT for experimental purposes to determine if lower-grade zinc ores can be shipped from the old D. C. and E. sheet ground mine in the Oronogo-Webb City district

Tri-State

Experimenting With Marginal Zinc Ores

TESTS made by sorting and screening yield satisfactory ore for shipping—New mill at Big Elk

✦ An interesting experiment is being carried on in the Webb City-Oronogo field by the Webb City Lead & Zinc Company, which may mean the reopening of the marginal mines of that area. The Webb City company, operating under leases, has erected a temporary experimental screen and picking belt on the old D. C. & E. mine, just south of the old Unity, in the Oronogo bottoms. The ore from this mine averages 4.5 per cent zinc, which is too low to be shipped to the Central mill of the Eagle-Picher company in Oklahoma. By screening the ore good results have been made, as they indicate averages of about 7 per cent zinc; the ore from the picking belt averages around 8 per cent. Ore of this grade can be shipped profitably to the Central mill. The experiments will be continued with various sizes and types of screens with the hope that possibly better results can be obtained in the treatment of material formerly not considered to be of commercial grade.

✦ A new mill has been started on the Big Elk lease on the Copper land, northwest of Treece, Kan., by the Semple Mining Company, according to C. Y. Semple, of Treece. The plant will treat the ores from the Big Elk and also the Early Bird lease. The old Early Bird mill has been converted to a tailing mill, and at present is treating the Muncie tailings, a property owned by the Federal Mining & Smelting Company.

✦ The Galena Mining & Milling Company, which recently constructed a tailing plant at Galena, has closed the mill to make some additions of equipment, according to R. L. Wagnon, of Joplin. Three Butchart tables, a filter, and a Dorr thickener are being added to the plant.

✦ C. C. and J. R. Cole, of Tulsa, Okla., have purchased a lease on the Blue Ribbon tract, south of Hockerville, Okla., from Harry Hawkins, for which they have contracted to pay $100,000 in deferred payments of $20,000 a year for five years. The Longhorn Mining Company has been formed to operate the mine.

Idaho

More Mines Plan Production

EXPLOITATION follows encouraging development—Placer miners start season

✦ Idle for several years due to lack of transportation facilities, the Riverside Copper Mining Company, on the Little North Fork, plans to start an active development campaign this season. The new road, built by the Forestry Department, now makes the property easily accessible and will permit of the movement of supplies by truck instead of pack trains. Dr. T. R. Mason, of Kellogg, is president and manager of the corporation.

✦ An extensive development program with early anticipation of entering the production class is under way at the property of the Corby Lode Mining Company, in the Pine Creek district, adjoining the Page mine on the west. Manager Eugene Tousley, of Spokane, states the lower tunnel is being retimbered for operations. The crosscut and drift on this level has been advanced about 660 ft., on a strong vein containing gold, silver, and copper.

✦ Placer miners in the Murray district are getting busy, taking advantage of the high water for sluicing and preparing the ground for bedrock operations as the water goes down. Both Prichard and Trail creeks will be the scene of activities.

✦ Sunshine Mining Company expects to complete the new four-compartment vertical shaft, extending from the surface to the 1,700-ft. level, by August. Equipment will be installed capable of hoisting 2,000 tons of ore a day. The new 600-ton mill unit has been completed and preliminary tests have proved satisfactory. This addition, together with the present 550-ton mill, will provide Sunshine with a milling capacity of over 1,000 tons a day. For the first three months of the current year the net income is reported at approximately $790,000, equivalent to 53c. a share on the 1,488,822 shares outstanding. For the corresponding period in 1935 the net income was 23c. a share. Silver produced during the quarter is understood to have totaled 1,762,627 oz., indicating an annual output of close to 7,000,000 oz., compared to 5,854,975 oz. in 1935.

✦ Development operations at the property of the Trapper Creek Mining Company in the Pine Creek belt are well under way, according to reports from Manager James Richardson. An examination has recently been made of the group by John B. Platts, mining geologist.

✦ The Sultan Gold property, near Elk City, is to be equipped with a milling plant, according to J. E. Jones, president. It is planned to have the mill in operation within six weeks. Jean Peters, consulting geologist for the company, has worked out details for the mine development program.

Australia

Government Advances Gold Mining Funds

MONEY is loaned to companies for prospecting and equipment —Large gold dredge starts operations

✦ The Commonwealth Government of Australia has since early in 1935 made available to the individual states £543,750 for development of gold mining. The program will be completed in June, 1938. These funds have been spent by the states in advances to companies and syndicates; provision of crushing facilities; water supply and transport facilities; and prospecting and geological research. Until 1939, £5,000 will be granted annually to the Council for Scientific and Industrial Research for researches into the treatment of gold and base metals. Unquestionably this policy of assistance has given employment and has increased the gold yield.

✦ The Broken Hill Proprietary Company has formed a corporation, Wellington Alluvials Ltd., with a capital of £250,000, in 2s. shares, to work by bucket dredging an extensive deep alluvial area along the Wellington River, N.S.W. The area has been under test since 1933.

✦ The bucket dredge of Cooks Eldorado Gold Dredging, N. L. Eldorado, Victoria, will commence digging in May. The plant weighs 2,100 tons, has 12-cu.ft. buckets, is electrically operated, will dig to 90 ft. and will have a capacity of 200,000 cu.yd. monthly. It will be the largest ever operated in Australia. The cost is £100,000.

✦ North Broken Hill, Ltd., Broken Hill South, Ltd., Zinc Corporation, Ltd., and Electrolytic Zinc Company have acquired a large parcel of shares in a new company, Associated Pulp & Paper Mills, Ltd., formed to lay down a plant at Burnie, Tasmania, for the manufacture of fine papers. The capital is £3,000,000 in £1 shares.

✦ The new treatment plant at the Central Norseman Mine, Norseman, W. A., was placed in operation in April. It will treat 4,000 tons monthly.

✦ The ore reserves of Paringa Mining & Exploration Company, Ltd., Kalgoorlie, are estimated at 78,300 tons assaying 5.75 dwt., plus 55,000 tons of probable ore. Plans for a treatment plant with a capacity of 5,000 tons monthly are being prepared.

✦ Bulolo Gold Dredging, Ltd., in association with Placer Development, Ltd., may acquire a substantial share interest in, and assume technical control of, Upper Watut Gold Alluvials, N. L., if check boring confirms estimates. The property of Upper Watut is on the Upper Watut River, New Guinea. A sluicing plant with a capacity of 1,500,000 cu.yd. annually will be in operation in August next.

✦ Tasman Tin, N. L., has been formed with a capital of £50,000 in 200,000 shares of 5 per cent each to acquire and develop the Anchor mine, near Lottah, on the east coast of Tasmania. Since 1932 the mine has been worked by open cut and a syndicate has treated 25,568 tons of stanniferous altered granite, recovering 108.5 tons of tin concentrate containing 70 per cent tin. Early this century the Anchor mine was worked on a large scale and equipped with 100-head of stamps and a full complement of jigs and Frue vanners.

✦ The Electrolytic Zinc Company is running its new flotation plant at Rosebery at two-thirds of its capacity of about 3,500 tons weekly. The ore contains over 2 dwt. gold per ton.

Fiji Islands

✦ Ore reserves of Aloha Central Gold Mining Company, N. L., in the Fiji Islands, have been estimated at 61,380 tons assaying 7.86 dwt. The lease is a small one centrally situated on the Tavua field. The installation of a treatment plant is under consideration. A central power plant is to be installed at Tavua by the principal companies operating there.

✦ On the Emperor mine, Tavua, Fiji, the new adit 90 ft. below the mill tunnel level has proved the downward continuation of the orebody, 6 ft. wide and assaying 15 dwt., with ore still in the face. A treatment plant for concentration, roasting, and cyanidation is to be installed on the Loloma mine, which has a capacity of 2,000 tons monthly.

Canada

Tax Program Encourages Mining Stability

PROPERTIES coming into production before 1940 will be exempt from Dominion taxation—Corporation tax slightly higher

✦ The question of mine taxation in Canada has now been settled for some years to come, with the announcements made recently in Ottawa in the course of presenting the annual budget. The Hon. C. A. Dunning, Minister of Finance, has achieved what appears to be a fair policy of taxation, under the circumstances, and this has been met with a general acknowledgment from the Dominion's mining men. As spokesmen for the various provincial governments had already promised that there would be no increase in mine taxation, this burning question can now be considered as settled in a way that will do much to encourage the further rapid development of the Dominion's mineral resources, particularly gold.

The chief points of Mr. Dunning's budget announcement are as follows: The depletion allowance for mining companies is 33⅓ per cent and for shareholders 20 per cent; both were 50 per cent up to two years ago. The corporation tax, for mines in common with all other corporations, is raised from 13½ per cent to 15 per cent of profits. A special concession is that any metalliferous mine coming into production between May 1, 1936, and Jan. 1st, 1940, is to be exempt from Dominion taxation for three years following the commencement of production. This last item has already created a notable interest among those engaged or concerned in making new mines, and is well calculated to stimulate a further healthy activity in exploration and development. Mr. Dunning also promised that his Government would impose no discriminatory legislation upon the mineral industry.

The Dominion Government's broad appreciation of the vital part mining now plays in the country's finance, as well as in its general development, is set forth plainly in Mr. Dunning's opening remarks about the mines: "The contribution which this industry has made to the economic well-being and indeed to the financial integrity of the Dominion during the depression years is well known. Great as the development has already been, a much greater future appears to lie in store." An additional practical mark of the Mackenzie King government's estimate of the mining industry's value to the country is the fact that it has repeated the $1,000,000 vote to the Geological Survey made last year by the Bennett government, and that it has voted $1,500,000 for new roads in the mining areas.

Quebec

✦ The 200-ton mill for Stadacona Rouyn, 2 miles south of Noranda, has now been completely financed and construction is being pushed vigorously. It is expected to be in operation by the end of August. The mine is partly developed to 600 ft. and the estimate of ore in sight is 170,000 tons of $8 grade. Operating costs are estimated at $4.50 to $5. Murray D. Kennedy is manager.

✦ Canadian Malartic produced during the first quarter of the year $159,219 from 26,469 tons milled, or $6.01 per ton, to give an operating profit of $44,848, or $1.67 per ton. The detailed costs per ton, typical of the new mines in this district were as follows:

	Per Ton
Diamond-drilling	$0.257
Development	1.181
Stoping	1.200
Milling	0.981
Office and supervision	0.228
General suspense	0.253
Head office, incidental	0.155
Total	$4.255

British Columbia

✦ The Edye Pass property, on Porcher Island near Prince Rupert, was acquired recently by the Reward Mining Company, and a complete camp has been shipped from Vancouver in preparation for the resumption of operations. The property adjoins the Surf Point mine, where the Timmins Corporation, of Montreal, has in operation a 20-ton flotation mill.

✦ A 25-ton Hadsel high-speed dry-grinding type mill has been ordered by Ashloo Gold Syndicate, and is expected to be installed by the end of June at the Syndicate's property, 30 miles from Squamish at the head of Howe Sound. W. V. Smithingdale is superintendent.

✦ The capacity of the mill at the Minto, in the northern part of the Bridge River valley, will be increased from 60 to 110 tons. The high-grade orebody in the River tunnel has now been opened for a length of over 400 ft. In April, 1,648 tons of concentrate and 121 tons of ore were shipped to the Tacoma smelter. The value of output was $42,457, and operating profit was $20,328, according to the president, William Warner.

✦ The new 150-ton mill at the Hedley Mascot commenced operations early in May. W. R. Lindsay, manager, states that although the ore is refractory and difficult to treat, it is expected recovery will average 88 or 90 per cent. The property adjoins the Nickel Plate mine, at Hedley.

✦ In the Ymir district, operations are proceeding satisfactorily at a number of properties. During March at the Yankee Girl, 3,715 tons of ore was milled and the value of output was $37,350. Work has been resumed at the Wesko and also at the Ymir Consolidated, where the mill is being operated at the restricted rate of 85 tons a day.

✦ A new record for monthly output was established in April at the Reno mine, in the Sheep Creek district, when bullion valued at $89,492 was produced from 3,736 tons of ore milled. The shaft

MILL AND UNLOADING TERMINAL of the tramway of the Windpass Gold Mining Company, in British Columbia. The average recovery is about 82 per cent by flotation and an additional 6 per cent on tables. The tailings are stacked adjacent to the mill for cyanidation

was completed recently to the eleventh level, and drifting started at that horizon.

✦ Increasing the capacity of the 50-ton mill to 100 tons is being considered by directors of the Kootenay Belle mine, in the Sheep Creek district. The third-level east drift on the "A" vein is being advanced through a 260-ft. band of argillite towards another body of quartzite which extends for a further distance of 1,500 ft. It is in this formation that vein enrichment in the district is customary.

✦ In the annual report of the Pioneer Mine at Bridge River, by H. T. James, general manager, positive ore reserves were estimated at 341,372 tons, averaging 0.518 oz. gold per ton, including 46,088 tons of broken ore. No provision was made in the estimate for ore below the fourteenth level, although during the year the program of deep development has proved the continuity of the vein to the 23d level, 2,800 ft. below the surface. However, drifting on the new low levels is not yet sufficient to serve as a basis for an estimate of reserves. Crosscuts have been driven from the shaft to the vein on the 15th, 16th, 17th, 20th and 23d levels, and very satisfactory results have been obtained in drifting. Crosscutting is also proceeding on the 26th level from the foot of the shaft, 3,200 ft. below the surface.

✦ A fireproof power house has been constructed at the Cariboo Gold Quartz Mine, near Wells, to replace that destroyed by fire on March 24. Three Ruston diesels developing a total of 1,575 hp. with English Electric generators are also being installed. It is expected operations will be resumed by the middle of June. Meanwhile, additional machinery has been installed in the mill and its capacity will probably be increased from 150 to 200 tons in July. R. R. Rose is managing director.

✦ At the Island Mountain, across Jack of Clubs Lake from the Cariboo Gold Quartz, 10,260 tons of ore was milled in the first quarter of the year, from which 4,681 oz. gold was produced, valued at $163,229, according to the manager, M. D. Banghart. Operating profit after allowing for taxes was $70,131 and net profit after all deductions was $8,058.

✦ At the annual meeting of Consolidated Gold Alluvials of B. C., Ltd., developing the rich deposits in the bedrock gravels of Lightning Creek at Wingdam, Cariboo, the general manager, D. Campbell Mackenzie, estimated that pillar reserves in the Sanderson mine amounted to 33,000 cu.yd. as at the end of March, containing 9,634 oz. gold, of a value of $290,000. It is expected that reserves having a value of $2,000,000 will have been established by the end of the year in this deposit, which occurs in the interglacial moraine.

Mexico

Labor Strike of Long Standing Settled

WORKERS RETURN to mines of Guanajuato Reduction & Mining Company after a six months' shutdown—Potential mining regions being examined by geological commission

✦ The Mexican mining industry approached summer with a somewhat improved labor situation. A strike against an American enterprise that had lasted for six months was settled. Labor department intervention averted some tie-ups. In one dispute disgruntled miners put aside their grievances to aid the company improve its properties as a means of providing more work.

✦ Guanajuato Reduction & Mining resumed work in all but one of its mines in the Guanajuato City sector, with the ending of a six months' strike under agreements made by Augustus MacDonald, company general manager, the Federal Labor Department, and strikers' representatives. The company is paying costs of the strike, 50,000 pesos (about $14,000), in five monthly installments of 10,000 pesos each, wages employees lost from April 17 to May 9, the date of making the agreements, and has raised its minimum daily wage from 1.50 to 1.65 pesos. The company was allowed to dismiss more men than the employees desired, but with the proviso that lay-offs are to be confined to workers receiving the highest salaries. The famous La Valenciana mine, long a producer, is not to be worked, because of the exhaustion of good pay ore. The company now has 1,060 men at work.

✦ Labor Department's intervention averted a strike at copper mines in the Santa Rosalia sector, Lower California, of Cia. del Boleo, S.A., a French enterprise. An agreement signed by General Manager August Nopper allowed most of the workers' demands, including free electric light, a weekly paid holiday, a 6 per cent wage increase, with the promise to elevate it to 33 per cent when the market price of copper the employees extract is 10.5c. (U.S.) per pound, and indemnities for illness and accidents. The Labor Department is arbitrating other demands of the workers.

✦ Although still refusing to permit Amparo Mining and Cia. Minera de Piedra Bola, S.A., American enterprises, to suspend work at their properties at Mineral de la Embocada and Etzatlan and Mineral de Piedra Bola and Ahualulco, Jalisco, respectively, the Federal Board of Conciliation and Arbitration has allowed companies to reduce the number of their employees at the rate of 15 men per month each, with an indemnity of 45 days' pay for every dismissed worker. The board reached this decision after investigating the companies' contention that they must quit because of unprofitable operation.

✦ Federal labor authorities induced disgruntled employees of Cia. Minera Mexicana de Namiquipa, S.A., operating gold, silver, and lead mines at Namiquipa, Chihuahua, to cancel a strike threat and to aid company financially to drain a flooded working and develop a reportedly rich silver orebody in another shaft, by foregoing money receipts for a paid weekly holiday for two months.

✦ Present and potential mining production sources in various regions of Mexico are being investigated by a geological commission of the Ministry of National Economy. The commission is now in Michoacan. Later it will visit all mining regions.

✦ Nacozari interests that recently took over the Santo Domingo mine, 17 miles from Nacozari, are installing diesel equipment, pumps, a hoist, and a rock crusher. This mine averaged weekly shipments of three carloads of ore to the Douglas, Ariz., smelter. The mine was formerly known as the Virgin de Plata, and now produces ore that assays about one-fourth of an ounce of gold, 30 oz. of silver, and from 8 to 10 per cent copper.

✦ After a long shutdown, Los Tres Reyes mine, near La Concepcion, on the borders of Actopan and Pachuca municipalities, Hidalgo, is to resume work soon as a result of the discovery of a rich gold-silver deposit. The mine is owned by Jesus Gil, Pedro Rodriguez, and Eusebio del Cueto.

✦ National Gold & Silver Mining is arranging to increase development of its Conejo Blanco and El Carmen properties, Taviche zone, Ocotlan, Oaxaca. Installation of a 200-ton mill is included in the program which is to be launched in May. The company is receiving considerable machinery and tools and expects to increase its force to 800 men soon. It wants the National Railways to build a branch that will connect the Taviche sector with their Oaxaca City-Ejutla division.

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Torreon Smelter

On page 241 of the May issue of *Engineering and Mining Journal* it was stated that the average composition of the slag from the Torreon smelter contained 8 oz. silver. This should read 8 grams per metric ton (equivalent to 0.23 oz. per short ton).

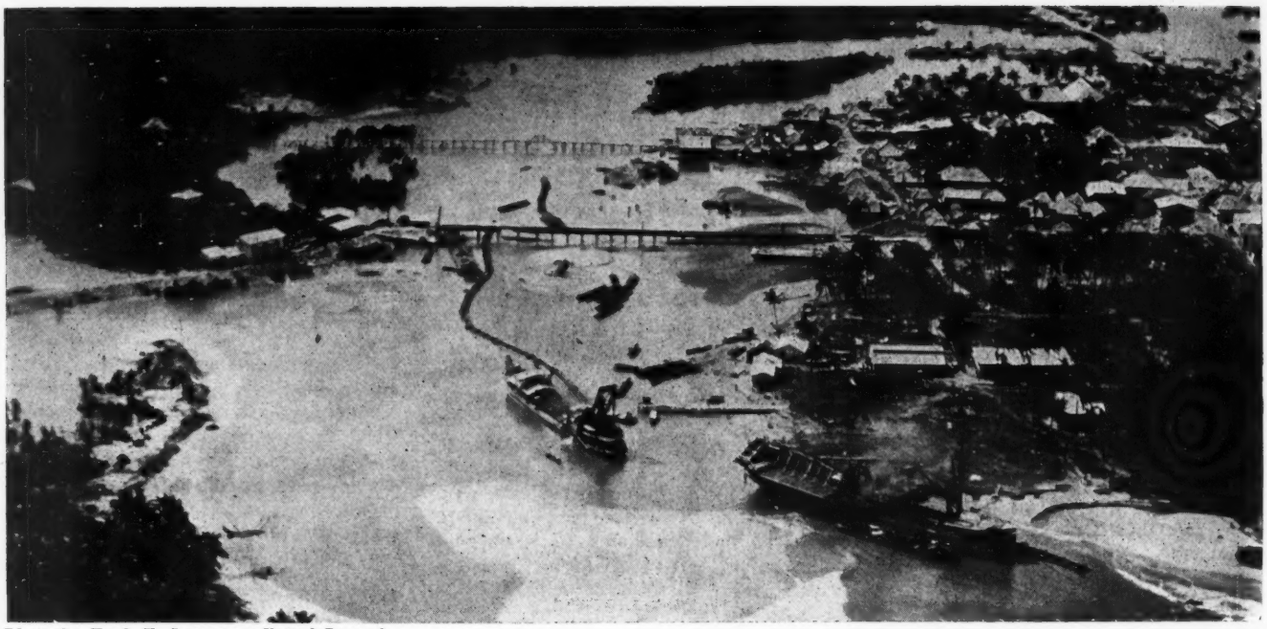


Photo by Hugh K. Lancaster, United Paracale.

THE PARACALE GOLD DISTRICT, Camarines Norte, Philippines. For the past two years this district has been under development and is now in production. Dredging operations are now under way by Marsman & Company. The two dredges in the photograph have completed removing overburden in the bay. United Paracale Mining Company, North Camarines Mining Company, and Coco Grove Placer Syndicate are operating in this district.

Native scoop and drag used by the Igorots in primitive mining methods. They were found at the Gold Wave Exploration Company's property in Baguio when an old tunnel was encountered

Philippines

Gold Production Up 35 per Cent in First Quarter

DIVIDENDS lower due to heavy expenditures for expanding operations and new equipment—New area being prospected in southern part of Luzon Island

✦ Gold production in the Philippines for the first quarter of 1936 showed a gain of nearly 35 per cent over the same period last year, the total being approximately $4,732,000 for 1936 and $3,510,000 for 1935. The total yield for February went over the $1,500,000 mark for the first time in history. March and April totals were around $1,650,000. At the end of March, 1935, there were 11 mills in operation, with a total tonnage of about 3,500 daily. On April 1, 1936, there were 15 ore-treating plants turning out bullion; two placer operations; two mills under construction; and a total tonnage of more than 6,000 tons a day.

✦ Dividends for the first quarter were paid by four companies, and amounted to $1,569,293. Benguet Consolidated paid $0.125 per share, a total of $750,000; Balatoc paid $0.175 per share, or $700,000; Itogon paid $0.00375, or $100,000; Ipo Gold paid $0.0025, or $19,293. (Par for Benguet and Balatoc is $0.50; for Itogon and Ipo, $0.05.) The total dividends were slightly lower than for the same period, the reason being that most of the companies are spending considerable for plant expansion purposes.

✦ The Big Wedge 150-ton cyanide plant, in the Baguio district, will be in operation in June or July. In Mindanao, at the southernmost end of the Islands, the East Mindanao Mining Company has started the construction of a new 150-ton plant.

✦ A new district, in the Province of Albay, some 200 miles south of Manila on Luzon, is now being prospected. The territory is entirely virgin ground. Though in every other district in the Islands traces of earlier workings have been found, in the Albay region there have never been any mining activities.

✦ A number of companies have been formed to prospect claims around Manito, on the Albay Gulf. The largest of these are the Cabit, Bicol Gold, and Monte Cristo. Results are said to be encouraging. Not enough is known about the district, however, for predictions to be made as to the future of the area.

✦ The 150-ton flotation-cyanidation plant of San Mauricio, in the Paracale district, was put into operation in March. The production during March was nearly $39,000 and in April, $75,000. Milling capacity is now being in-

creased to 200 tons a day, with further expansion likely if mine development continues as favorable as it has been so far.

✦ A new 150-ton cyanidation plant has been put in operation by Benguet Consolidated on its Cal Horr property, in the Baguio district. Production, started in January, 1936, has been between $37,500 and $40,000 a month.

✦ Demonstration Gold Mines, Ltd., has announced that regular quarterly dividends will be started in June, probably of $0.005 a share. The company made a net profit of $86,000 during the first quarter, from a total production of more than $190,000. It is believed that mine development work will warrant an increase in mill capacity from 175 to 300 tons daily.

✦ Announcement was made in May that Marsman & Company had concluded an arrangement with the Hongkong Government for the exploration of wolfram deposits in the New Territories, near Kowloon. Mining engineers from the Marsman organization have made preliminary surveys of the property, and it is believed that a sizable ore body may be developed. Exploration tunnels will be started immediately.

✦ Mining legislation will be one of the chief topics of discussion at the next meeting of the Philippine Assembly, to be held in June. All mining laws were suspended last November when the Commonwealth was brought into being. A complete new set will be drafted. A number of the legislators have visited the various mining districts with the object of obtaining first-hand information. The newly created Chamber of Mines, which replaced the defunct Gold Mining Association, is expected to aid the legislators considerably in an intelligent study of the mining situation here and in drafting intelligent and comprehensive laws for the best interests of all concerned.

Yugoslavia

✦ Trepca Mines, producing lead, silver, and zinc in Yugoslavia, realized an average gross of £1 13s. 4d. per ton of ore from concentrates sold during the March quarter. Profit, subject to depreciation and taxation, was £132,773, which is at the rate of nearly 50 per cent annually on the company's total capital. Its April outputs from 50,937 metric tons of ore milled were 5,424 metric tons of 79.96 per cent lead concentrates averaging 26.75 oz. of silver per ton and 7,116 tons of 50.31 per cent zinc concentrates.

South Africa

Gold Mines Subject to New Tax Laws

DIFFERENT VIEWS held by mine operators as to advantages of new revenue measure—Higher employment on the Rand

✦ Leading Witwatersrand mining interests are expressing differences of opinion on the effects of the new Union of South Africa tax law. Those favoring it believe it will encourage developments and expansion of outputs. The others say—and no one disputes them—that taxation of the gold-mining companies is left far too high. Neither of these views is reflected in any slowing down of prospecting and exploration activities, or in a diminished progress of development work and plant expansion. It is likely that the companies will make rather better speed in these directions because of the tax law having somewhat lightened their load of dissatisfaction, and because of profits being generally substantial after tax and other deductions. Chairman Stokes of Modderfontein B Gold Mines said that on an annually declining profit, taxation of the company had been £309,472, £182,435, and £188,435, and on the basis of the new tax program would be £247,000 for 1935. A. F. Mullins, chairman of Geldenhuis Deep, welcomed the simplification of taxation and said it would bring the company a measure of relief. Chairman Lawrence of Durban Deep also expressed himself pleased with the new taxation. These three views are about what a cross-sample of those held by all would yield. For instance, Chairman Mackenzie of Robinson Deep said at the annual meeting that the new taxation measures were generally welcomed, as they were simpler, but that the burden on the gold-mining industry was by no means lessened; it might even increase the mines' contribution.

✦ Operating costs on the Witwatersrand have been tending to show a slight increase, as would be expected in a district visited by a prosperity which has caused scores of thousands of additional workers to be employed.

✦ The Northern Rhodesia copper-mining companies are continuing to demonstrate their great earning power. Roan Antelope Copper Mines made a profit of £196,000 the first quarter of this year. Debenture interest and redemption and depreciation reduced the final net to £136,000, subject only to taxation. It is apparent that the cost of producing blister copper, before the deductions mentioned but including all London expenses, was slightly less than £20 per long ton. The allowance for depreciation is £37,500 per quarter, or £150,000 annually; but instead of using the word "depreciation" this allowance is accurately stated in the Roan reports as "Reserve for Replacements and Obsolescence," that of course being what the commonly used term "depreciation" should properly include. This charge, amounting to about £3 per long ton of copper produced under the prevailing restriction rule, clearly should be added to costs, though in the accounting practice of many companies it is not.

✦ Anglo American Corporation of South Africa plans to segregate its large interests in diamond-producing companies and turn them over to a holding company which it will form for that purpose.

✦ Though the extensive drilling campaign in progress on the Witwatersrand is by no means yielding uniformly favorable results, what Venterspost's No. 7 borehole has made is a disclosure that is both excellent and interesting. At a vertical depth of 3,224 ft. this drill entered 50 in. of 6.1-dwt. ore, next passing through 103 in. of unpayable, and then cutting 36 in. which averaged 10.34 dwt., borehole widths. This hole is in the southern area of the company's property, but a considerable distance north of borehole No. 12, which found 3.6 dwt. over 21 in. at a depth of 4,056 ft.

✦ Ashanti Goldfields Corporation has declared an interim dividend of 22½ per cent. This is the same as a year ago, but last year a further 20 per cent was paid in September and 40 per cent in January, making 85 per cent for the year. Developments in this and other Gold Coast properties are continuing generally favorable, and that region which Ashanti and two or three other properties for years prevented from being wholly discredited now gives promise of becoming one of the world's most important gold producers.

✦ Although Consolidated African Selection Trust was a continuous dividend payer throughout the depression years, it apparently is beginning to feel the effects of the greatly improved conditions in the diamond trade, as it has just declared an interim dividend of 30 per cent free of tax. A year ago 25 per cent, taxable, was declared, the total for 1934-35 being 65 per cent, less tax. This company, of which A. Chester Beatty is chairman, has a most remarkable dividend record.

✦ Orange Witwatersrand Areas has been organized with the small capital of £50,000 to option and prospect properties in the Vredefort district of the Orange Free State, Union of South Africa. W. E. Bleloch, consulting geologist, is chairman.

PERSONAL ITEMS

Friends of Ernest Gayford, General Engineering Company, Salt Lake City, Utah, will regret to learn of the death of Mrs. Gayford on May 5. She succumbed to a heart attack after a prolonged illness.

H. F. Yoder, assayer-chemist, is now with the Mollin Mining Company at Searchlight, Nev.

A. Chester Beatty returned to London in April from a winter vacation spent in Egypt.

D. C. Leggett severed his connection with Laguna Gold Mines in April and is now manager of Gold Lake Mines, Ltd., at Bissett, Manitoba.

J. Whitehouse, managing director of Trepca Mines, Ltd., recently completed an inspection of the property in Yugoslavia.

F. A. Brien, who came to the Philippine Islands a few months ago for United Paracale, is now on the staff of Balatoc as a mine shift boss.

Enoch Perkins, mining engineer of New York City, will leave the United States at the end of June en route for Australia and New California. He expects to return at the end of the year.

R. A. Johnson has left Fort Peck Dam, Montana, where he was a tunnel inspector for two years, and is now acting as field engineer for The Dorr Company.

W. P. Henry has resigned as president of the Central Eureka Mining Company, Sutter Creek, Calif., because of ill health. He is succeeded by **C. C. Prior,** formerly vice-president of the company.

Prof. G. A. F. Molengraaf has received the highest award of the Geological Society of London, the Wollaston Medal, for his achievements in geological research in the Transvaal.

Arthur D. Storke is in Northern Rhodesia visiting Roan Antelope, Mufulira Copper, and Rhodesian Selection Trust, of which three companies he is managing director.

J. Fraser Brown, vice-president of Masbate Consolidated, sailed for Europe on an extended business trip during April. He plans to spend most of his time in England and Scotland.

A. W. Dodd has been elected vice-president of the American Zinc, Lead & Smelting Company, **W. N. Payne,** secretary and treasurer, and **William G. Irwin,** chairman of the executive committee.

V. D. Perry and **A. Cramer,** geologists for Cananea Consolidated Copper Company and Anaconda Copper Company, respectively, recently inspected the Penryn gold mining district near Auburn, Calif.

William E. Piper, of the sales engineering staff of The Dorr Company, has resigned his position as of July 1. He will be assistant chief engineer of the Standard Lime & Stone Company, with headquarters at Baltimore, Md.

Charles F. Fletcher has joined the staff of United Paracale and Coco Grove Placer Syndicate (Philippines) as master mechanic. He has had an extensive experience in the western United States and in Chile.

E. H. Gould, registered mining engineer for Battle Creek, Mich., is examining mining properties in the Mispah mining district, Elko County, Nev. After completing his work there he will go to Colorado for two more examinations.

Maurice Rey, of the engineering faculty of University of Liége, Belgium, has been granted an "advanced fellowship" by C.R.B. Educational Foundation Inc., 420 Lexington Ave., New York, and will make a three months' trip from June to September in the United States and Canada, visiting flotation mills and metallurgical plants.

MAURICE REY

Ray J. Barber, consulting engineer, has returned to his office in the Monadnock Building, San Francisco, after an extensive business trip to Colombia, S. A., where he investigated placer properties for American and Colombian clients.

E. R. Bennett, formerly superintendent at the Zeibright mine of Empire Star Mines Company, Ltd., near Emigrant Gap, Calif., has been placed in charge of the company's Pennsylvania mine, in Browns Valley. **J. M. Becker** succeeds Mr. Bennett at the Zeibright property.

J. H. Marsman, president; **Major A. Beckerleg,** chairman of the board of consulting engineers; **B. S. Ohnick,** director, all of Marsman & Company, went to Hongkong during May to conclude an arrangement with the Hongkong Government for the exploration of wolfram deposits in the New Territory.

Earl Tappan Stannard, president of Kennecott Copper Corporation, and **Louis Shattuck Cates,** president of Phelps Dodge Corporation, received honorary degrees of doctor of engineering, conferred by Michigan College of Mining and Metallurgy on class night, June 4. Mr. Stannard addressed the class.

Dewey J. Sabin, mining engineer, has established a consulting office in Buenos Aires, Argentina, his address in that city being Calle Solis 227. He is prepared to examine and report on mining properties in the Argentine, to supervise or operate milling plants, and to do general mining engineering work. He has available a complete ore-testing laboratory.

S. Power Warren has completed his work with the Hughes-Mitchell Processes, Inc., at Torrance, Calif., and will become affiliated with the Mining Research Corporation of Toronto, Canada, a firm of consulting mining and metallurgical engineers. He will be available to his clients either in care of the abovementioned firm at 320 Bay St., Toronto, or at his permanent address at Golden, Colo.

Andre Orban, chief metallurgist at the Baelen (Belgium) plant of the Vieille Montagne company, and **Louis Tremolet,** chief metallurgist at the company's plant at Viviez, France, accompanied by **Louis Hirshler,** Vieille Montagne consulting engineer, of New York, left that city on May 21 for Montreal, from which point they will proceed west to visit electrolytic zinc refineries in western Canada, Idaho, and Montana.

Roscoe H. Canon, mine superintendent at Itogon, has been promoted to the position of assistant general superintendent at United Paracale. **Warren Gilkison** arrived in Manila April 2 to take Canon's place at Itogon. He is a graduate of the Colorado School of Mines class of 1923, and comes to Itogon after six and a half years at the Cia. Real del Monte y Pachuca, Mexico, as mine superintendent.

F. W. Maclennan, general manager of Miami Copper Company at Miami, Ariz., will resign from that position some time this month and will thereafter reside in Los Angeles. Mr. Maclennan has been with Miami for more than twenty years. He will continue to act for the company as a consultant. **A. S. Winther**, general manager for the past six years for Rhokana Corporation, operating in Northern Rhodesia, will assume the post at Miami formerly held by Mr. Maclennan.

F. F. Colcord, vice-president of the United States Lead Refinery, Inc., was elected to membership on the Engineering Foundation board at the meeting of the board of directors of the A.I.M.E. held on May 21, succeeding **E. De Golyer. J. V. N. Rynders,** consulting engineer, was reappointed a member of the Hoover Medal Board of Award. The Mining Society of the University of Alaska College, Alaska, was recognized as an Affiliated Student Society. Presentation to **G. E. Delprat,** Melbourne, Victoria, Australia, with a certificate of honorary membership, was announced. **R. W. Hyde,** metallurgical engineer, Dwight & Lloyd Sintering Company, was appointed representative of the A.I.M.E. on the sectional committee on Standardization of Graphical Symbols and Abbreviations for Use on Drawings.

OBITUARY

R. J. Lemmon is returning to England after an extended visit to Canada and Australasia.

Joseph L. Obermuller, general manager of Cia. Santa Niña Gold Mining Company, Navojoa, Sonora, Mexico, is in New York on company business.

Louis D. Huntoon, consulting mining engineer, of New York City, was recently in Toronto and Noranda on professional business.

K. K. Hood, formerly with the Alan Wood Mining Company at Dover, N. J., is now manager of the Peru Mining Company at Deming, N. M.

Ernest Burgess is now general superintendent of the Ipo Gold Mines (Philippines), taking the place of James E. Hall, who was killed in an accident March 1.

Gilbert E. Campbell, former engineer and mine foreman for the First Thought mine, in Washington, has joined the staff of United Verde Branch, Phelps Dodge Corporation, Jerome, Ariz.

J. F. Mitchell-Roberts, export manager of United Oliver Filters, has just completed an extensive inspection visit to the Philippines which took him to every producing plant. He left early in May for the States.

H. H. Booker and **N. A. Fittinghoff,** both formerly of the Benguet Consolidated staff, have joined the Soriano interests, Booker as mine superintendent for Masbate Consolidated and Fittinghoff as chief metallurgist.

William C. Kinnon has been appointed mill superintendent for Southwestern Metal Mines, Cleator, Ariz. For the past two years Mr. Kinnon has been in charge of the Harqua Hala cyanide plant.

Darrell Gardner has been appointed mine superintendent of Magma Copper Company, Superior, Ariz., to fill the vacancy caused by the death of Herman Forsnas. Mr. Gardner has served as assistant mine superintendent for the last three years.

George T. Scholey, chief engineer of the Balatoc Mining Company for the past six years, has left the company to become head of the recently established mine consultation department of L. R. Nielson & Company, of Manila. **R. L. Loofbourow,** assistant to Scholey at Balatoc, has been promoted to chief engineer.

S. G. Turrell, Far Eastern representative of the American Cyanamid Company, spent several weeks in the Philippines recently, and visited the Baguio, Paracale, and Masbate districts. His headquarters are at Melbourne, Australia, and he gave several exhibitions of Australian mining scenes filmed during his tours of that country.

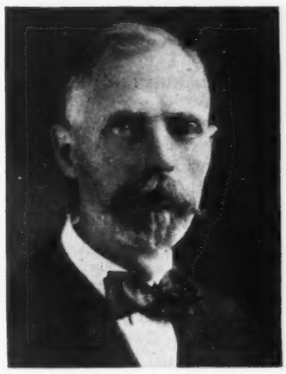
A. B. Parsons, secretary of the A.I. M.E., delivered the commencement address at the graduating exercises of the South Dakota School of Mines on May 28, on which occasion there was conferred on him the honorary degree of doctor of engineering, in recognition of his contributions as editor, journalist, and author to the literature of the mining industry and his work for the advancement of the profession of engineering.

Mark Channon - Moorehouse, Rand consulting mining engineer, died recently in South Africa at the age of 65.

William Julius Gau, mining engineer, metallurgist, and geologist, long identified with the mining industries of the Rand, died on April 1 at Johannesburg at the age of 58.

James Louis Hall, mine superintendent of Benguet Consolidated Mining Company, was killed recently by falling into a shaft at a company mine near Baguio, P. I. He was 41 years old.

Fayette A. Jones, mining engineer, civil engineer, metallurgist, and educator, died at Albuquerque, N. M., on April 4, at the age of 77. Dr. Jones had been a prominent citizen of New Mexico for nearly 50 years. His degrees in both



FAYETTE A. JONES

mining and civil engineering were conferred by the Missouri School of Mines. He served as president of the New Mexico School of Mines for eight years and was for some time connected with the United States Geological Survey. His activities in the fields of mining, geology, archeology, and anthropology took him all over the United States and into Alaska, Canada, Mexico, Central and South America, and to many islands in the Pacific.

Albert H. Low, formerly head of the chemical department of the Colorado School of Mines and one of the founders of the Colorado Scientific Society, died at Denver on April 9 at the age of 81.

Colonel James Waite Howard, consultant mining engineer, and president of Howard Inspection and Testing Laboratories, at Newark, N. J., died at East Orange, N. J., on May 25, at the age of 76.

Robert Daniel Lauderdale, veteran mining engineer and miner in Mexico, who came to the country in 1880, died recently at his home in Guadalajara, Jalisco. He was a personal friend of Gen. Porfirio Diaz and other Mexican notables.

Leo Springer, Canadian mining man and president of Ceres Exploitations, Ltd., was killed in an airplane crash at Chibougamau Lake, north of Amos, Quebec, on May 23. **Wilson Harold Clarke**—"Clarkie"—Canadian ace flier for many years, was also fatally injured in the crash.

Thomas J. Mateer, manager of Arbade Gold Mines, in Ontario, and formerly superintendent of Reno Gold Mines, at Salmo, B. C., died recently in Toronto. Mr. Mateer was a graduate of Queen's University, and had done extensive metallurgical research. A decade ago he was mining and metallurgical engineer for the National Lead Company and the Combined Metals Reduction Company.

Edwin H. Garthwaite, retired mining engineer and at one time associated with John Hays Hammond, died at his home in Berkeley, Calif., on April 27, aged 78. Mr. Garthwaite was born in San Francisco and attended the University of California before completing his training at Freiburg, Germany. For twenty years he was active in the United States, Mexico, and Central America, later going to Rhodesia and the Transvaal with Mr. Hammond, and serving as resident consulting engineer for the British South Africa Company, an organization controlled by Cecil Rhodes. Since his retirement 30 years ago, Mr. Garthwaite served as secretary of the Oakland Outlook Club and secretary of the 1880 Class of the University of California.

S. D'Arcy Rickard, late president of the Rickard Engineering Corporation of New York City, died in a sanatorium at Tucson, Ariz. on April 9, 1936, aged 49 years. Mr. Rickard was born at Anaconda, Mont., on Aug. 28, 1886, the son of Stephen and Constance Rickard. He obtained his early education in the Wyman and Manual Training School, of Denver, Colo., was later associated with A. W. Warwick on mine examinations in Sonora, Mexico, and was employed as an assayer and chemist at the mines in Duquesne, Ariz. His college education was obtained at Denver University and Sheffield Scientific School at Yale University. He was a member of the class of 1910, Sheffield, and of the Berzelius Society. Following his college work, Mr. Rickard was associated with the Denver Fire Clay Company, of Denver, Colo., and later with Gilbert & Barker Company at Springfield, Mass. For a time he was associated with the Flexible Steel Shaft Company in Chicago and later became consulting engineer for the Wayne Oil Tank & Pump Company, at Fort Wayne, Ind. Mr. Rickard was the inventor of the Rickard muffle, used on some Dwight-Lloyd sintering machines, which effected a saving in fuel. He had spent much time in Mexico in mine examination. In 1927 Mr. Rickard organized the Rickard Engineering Corporation and developed the Rickard oil burner. In 1930 he sold this business to the General Motors Corporation and was then forced to retire because of ill health. The next few years were spent in El Paso, Tex., Los Angeles and Altadena, Calif., and finally at Tucson, Ariz. He leaves his wife, Bernice Dorothy Rickard, and two brothers, Brent N. Rickard, manager of the El Paso smelter of the American Smelting & Refining Company, and Greville Rickard, an architect in New York City.

LETTERS

Emergency Kit for Air Travel

The Editor:

An ever-impending possibility in all air travel, particularly in flights over wild and uninhabited country, is the necessity of making a forced landing. If such a landing can be safely made near to human habitation, the pilot and his passengers can generally secure lodging and transportive aid, and their experience will simply be regarded in the light of an additional adventure or thrill, without any great physical discomfort. If, however, a plane is forced to land in an extensive, uninhabited region, the flyers will be forced to rely on their own ingenuity to return to civilization.

During the last few years I have talked with a number of people who have had the misfortune of cracking up in hazardous country. In one case the survivor was one who, with two companions, struggled for four weeks to return after crashing only 100 miles from his destination. In spite of the fact that he was an expert woodsman—a real sourdough prospector—he could not get through, and one of his companion died before a rescue plane found them. The particular deterrent to their getting out unaided was, in this case, lack of snowshoes.

Even pilots and flyers who make long hazardous flights in planes or balloons are prone to forget that they may be forced down. During the recent Gordon-Bennett balloon race in Chicago, in which it was practically a foregone conclusion that the winds would carry the bags over uninhabited Canadian country, I saw several crews who were ready to leave with no equipment except a jar of water, a bit of fruit or chocolate, and a rubber boat.

Anyone starting on a long trip to the Hudson Bay country by canoe or on foot with such an outfit would be regarded as insane.

The fact that the pilot may or may not be a good woodsman should not influence the selection. A good woodsman requires the same things that a poor one does and has only the advantage of being a little more familiar with the routine of cooking, chopping, and foraging—shifting for himself.

The emergency kit described herewith is recommended after considerable study of requirements, much discussion with aviators and air travelers, and after many years of experience in regions where a man's welfare depends entirely upon the quality and durability of his equipment. The contents of one's own kit will, of course, vary with the route or region over which the flying is done. A plane operating between Chicago and St. Louis will not require the outfit that one will when operating between Winnipeg and Whitehorse, Canada. It is not necessary to carry snowshoes in the tropics nor does a water-distilling set have much value in a trans-Saharan flight. The selection of the proper items and the quantity should be made after careful consideration of the length of the flight, the kind of terrain flown over, the season of the year, and the number of passengers carried.

A list of material to be included in an emergency kit follows:

Snowshoes — Bear-paw Pattern . . . One pair for each passenger, including moccasins and woolen socks. Every plane that flies over uninhabited country in the northern latitudes during the winter should be equipped with snowshoes. It is absolutely impossible to travel in deep snow without them, and under such conditions they are just as necessary as life preservers are to water craft.

Emergency Rations . . . Bitter chocolate; pea meal; desiccated vegetables, fruit, and soups; bacon; saccharine; tea; coffee; flour; baking powder; salt; and a small aluminum cooking outfit. The selection of rations depends largely on where the flight is made. If over extensive uninhabited country, a supply sufficient to last the flyers two to three weeks should be carried. Bitter chocolate is preferable to the sweet kind, as it is not consumed so quickly. Desiccated vegetables and fruits of excellent quality and wide variety may be obtained in any large sporting-goods store. The food should be packed in waterproof tins in a pack sack with shoulder straps for carrying. If the flight is made over thickly populated country, a few extra sandwiches or chocolate bars may be sufficient.

Water, Water Bags, and Canteens . . . For long transoceanic flights a small distilling outfit may be found exceedingly convenient. In the tropics, where the water is often dangerous to drink, a pocket filter is very useful and fairly effective.

Fly Dope (Oil Pine Tar, Pennyroyal, Castor) . . . The fly dope and cheesecloth are extremely important in the fly country of the North. The items weigh but little, but are a powerful remedy for the misery which black flies, no-see-ums, and mosquitoes can inflict.

Ten Yards of Cheesecloth . . . In the tropics head nets and sleeping nets are advisable.

One Four-Pound Single-bitted Axe . . . A single-bitted axe is preferable to a double-bitted one because it can be used for pounding as well as chopping.

Hack Saw With Extra Blades.

Matches in Water-proof Match Box . . . The hard-rubber waterproof match box which will float in water is recommended.

Hunting Knife . . . A 5-in. to 8-in. blade of the best quality steel is recommended. In the tropics a machete will prove useful.

Box Compass (With needle at least 2½ in. long) . . . A compass with a fairly long needle is much more satisfactory for woods travel than one with a short needle.

Marble Game Getter and Ammunition . . . This arm, which shoots a 44-calibre ball or shot and a 22-calibre cartridge, can be obtained only by special arrangement. It is made with a 12-in., 15-in. or 18-in. barrel.

H. & R. "Folding" Single Gun and Ammunition . . . (May be had in 410 gage, 20 gage, 16 gage, or 12 gage).

The choice of a gun varies with the individual. In general, in regions where arms are required for self-protection from wild animals or natives, the choice lies in the range between large-calibre revolvers or automatics and machine guns, including rifles. A shotgun is preferable to a rifle or revolver because more people can shoot effectively with this kind of gun.

Fish Line, Hooks, Flies and Artificial Bait . . . The selection of fishing tackle should be based on the kind of fish and fishing which exists in the country over which the flight is made.

Flash Light . . . This should be a 3-battery light or larger.

Very Pistol and Smoke Bombs.

First-Aid Kit . . . The first-aid kit should be one costing $8 to $10 or more. In snake country a snake bite outfit should be included.

Whiskey and Tobacco.

One Dozen Assorted Nails.

Rope—50 Ft.

A Pair of Strong Pliers or a Wire Cutter.

Blankets or Sleeping Robe . . . The down-filled, canvas-covered robe with snaps on the sides so that it can be made into a bag is recommended above all others for northern or winter travel. Pneumatic mattresses should be avoided when the weather is chilly or cold. If the flyer is wearing a fur-lined flying suit, a sleeping outfit may be omitted.

A Rubber Boat . . . (Particularly necessary for over-water flights without pontoons. Twelve-pound boats will carry a man easily.)

HELMUTH BAY.
Rand, McNally & Company,
Chicago.

Aid to Prospectors

The Editor:

The Quebec Prospectors' Association has been in existence for the past three years and its membership covers the entire Province of Quebec. Our aim is to help the prospector in every way, and consequently we are in a position to recommend bona fide prospectors to any individuals or syndicate who wish to engage in the discovery of mines in Quebec or anywhere else in the Dominion of Canada.

We have already had several enquiries from one or two syndicates from New York and have given them the benefit of our experience. You may pass this information on through the medium of your paper and we will be glad to furnish further information should you request it. The organization is not formed for profit, and the directors and executive, all capable and responsible men, give their services free.

QUEBEC PROSPECTORS' ASSOCIATION.
4143 Rue St. Dennis
Montreal, Canada

NEW BOOKS

A Caetani Memorial

Robert Peele has recently completed a biographical memorial of Prince Gelasio Caetani, which will be published shortly. Caetani graduated from the Columbia School of Mines in 1903. Until 1914 he was a practicing mining engineer and metallurgist in the West. He took an important part in the Great War, was elected an Honorary Member of the A.I.M.E. in 1923, was Italian Ambassador to Washington from 1922 to 1925, and died in October, 1934. The memorial will be in the form of a small book, of about ten pages, with frontispiece portrait. Requests for copies by non-subscribers to the publication fund should be sent to "The Science Press," Lancaster, Pa. Price per copy, $1.25.

Mining Geology For the Layman

TREASURES IN THE EARTH. *By Edward F. Fitzhugh, Jr. The Caxton Printers, Ltd., Caldwell, Idaho. Pp. 130. Illustrations 16. Price $2.*

Probably few attempts have been made to present the technical aspects of mining geology in non-technical language, but in this book the author has succeeded admirably in elucidating for the layman such abstruse matters as magmas, ore deposition, secondary enrichment, and earth structures. His purpose is to refute the idea that chance alone governs the discovery of ore, and to show the value of geology as a tool in appraising types of ore deposits and guiding mine development. "For determining the worth of the prospector's find there is no alternative for the science of the earth."

Introducing the reader to molten magma, "the common ancestor of all rocks and of all mineral deposits," the author explains the formation of batholiths, the migration of mineral-bearing solutions, and the deposition of ore in various kinds of channelways. Mineral deposits are classified as deep-seated, intermediate, shallow-seated, and contact, the first three with reference to their persistence in depth, and the last with reference to its occurrence near the edge of a batholith. Secondary enrichment by ground water is illustrated by notable examples. To illustrate the principles of faulting the author devises an ingenious experiment with a block of cheese, which the reader can carry out for a better understanding of the nature of faults and their effect on the dislocation of ore veins. Finally, brief reference is made to drilling and geophysics as means of ascertaining mineralogical and geological conditions below the surface of the earth. The author is to be congratulated on his facility in handling a technical subject in a popular manner.

Royalties and Rents

MINING ROYALTIES AND RENTS IN THE BRITISH EMPIRE. *Mineral Resources Department, Imperial Institute, London, S.W.7. Pp. 183. Price 3s. 6d.*

The amount and method of assessment of royalties are regarded as matters of considerable importance in the development and prosperity of a mining industry. The extent of these royalty charges may be illustrated by the fact that coal in Great Britain pays nearly £5,000,000 per annum; in the Federated Malay States, tin pays nearly £1,000,000, whereas in the Union of South Africa the profits tax, excess profits duty, etc., on the gold industry produced over £13,000,000 per annum in 1934-35.

A glance through the document shows that royalties levied on certain minerals (*e.g.* coal) are roughly uniform in many parts of the Empire, but in the case of other minerals (*e.g.* gold) wide divergence occurs, both as regards the amount and basis of the charge.

Gold and silver in Great Britain, being "royal metals," belong to the Crown and the royalty levied is usually 2 to 4 per cent of the value won. No royalty is charged on gold won from gold-mining leases in Queensland, Western Australia, or in New Zealand, but the last-named country levies an export duty. An *ad valorem* tax is favored by many countries; the Anglo-Egyptian Sudan levies 2 per cent, while 5 per cent is specified in Kenya, Tanganyika, Uganda, North Borneo, New Guinea, and Fiji. Southern Rhodesia graduates the tax between 2½ to 5 per cent, according to the recovery of gold per ton of ore. Nigeria charges 6 per cent; Sierra Leone, 9 per cent; and in South-West Africa and Sarawak, the rate is 10 per cent *ad valorem*. On the other hand, a tax on profits is adopted by certain countries; thus the Union of South Africa takes 4s. per pound sterling; most provinces in Canada, on gold obtained from reef workings, levy 3 per cent upwards on profits exceeding $10,000 per annum. British India takes either 7½ per cent of the profits or 2½ per cent of the gross value. In Mysore, 5 per cent *ad valorem* is levied in those years when a profit is made, and Hyderabad Deccan reduces the standard royalty (5 per cent) to one-half if the mining is carried on at a loss. The Union of South Africa and certain other countries levy a gold-premium tax in addition to the ordinary tax which is assessed against production.

PUBLICATIONS RECEIVED

Geology of the Klerksdorp-Ventersdorp Area. By Louis T. Nel. Geological Survey, Union of South Africa, Pretoria. Pp. 167. Price 10s. 6d.

Ore Concentration (Statistics), Metallurgical Results, and Concentration Reagents. By T. H. Miller and R. L. Kidd. U. S. Bureau of Mines, Washington, D. C. Pp. 16. Price 5c.

Detachable Rock Drill Bits, Progress Report on Investigation of. By McHenry Mosier. Information Circular 6877. U. S. Bureau of Mines, Washington, D. C. Pp. 9.

Schwimmaufbereitung (Flotation). By W. Petersen. Published by Theodor Steinkopff, Dresden, Germany. Pp. 337. Price, bound, 19.50 Rm.

Abfallstoffe der anorganisch-chemischen Industrie und ihre Ververtung. By Emil J. Fischer. Published by Theodor Steinkopff, Dresden, Germany. Pp. 156. Price, bound 10 Rm.

Mineral Commerce and International Relations. By Edward Sampson. Reprinted from Journal of Franklin Institute, January, 1936. Pp. 58.

James M. Degnan has been appointed general sales manager of the Hill Diesel Engine Company, Lansing, Mich., according to an announcement by James R. Tranter, president of the company.

Anhydrous Sodium Sulphate From Saline Deposits or Brines by a Four-stage Process. By J. E. Conley and E. P. Partridge. U. S. Bureau of Mines Report of Investigations 3299. Superintendent of Documents, Washington, D. C. Pp. 18.

The Silver Belt and the Sunshine Mine of the Coeur d'Alene District. By C. E. Julihn and F. W. Horton. U. S. Bureau of Mines Information Circular 6876. Superintendent of Documents, Washington, D. C. Pp. 16.

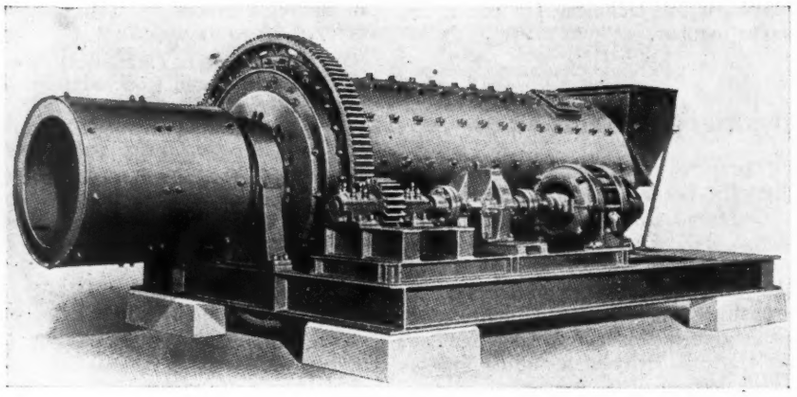
Chemical Analyses of the Rocks, Ores, and Minerals of Southern Rhodesia. By E. Golding. Bulletin 29. Geological Survey, Salisbury, Southern Rhodesia. Pp. 105. Price, 6d. Postage abroad 2d.

Chart for Determining the Performance of Centrifugal Fans. By G. E. McElroy. U. S. Bureau of Mines Report of Investigations 3298. Superintendent of Documents, Washington, D. C. Pp. 30.

Flotation of Langbeinite From the Potash Field of New Mexico and Texas. By F. D. DeVaney and S. R. B. Cooke. U. S. Bureau of Mines Report of Investigations 3300. Superintendent of Documents, Washington, D. C. Pp. 4.

Oscillations Due to Corona Discharges on Wires Subjected to Alternating Potentials. By J. Tykocinski Tykociner, Raymond F. Tarpley, and Ellery B. Paine, Bulletin No. 278, Engineering Experiment Station, University of Illinois, Urbana, Ill. Pp. 56. Price 60c.

EQUIPMENT NEWS



Blade Mill

Allis-Chalmers Manufacturing Company, of Milwaukee, Wis., has announced a new piece of machinery designated as a blade mill. It is a special development for washing, disintegrating, and cleaning ores, stone, and other products containing a large amount of clay, slime, or other materials that are detrimental to subsequent processes of treatment. The inner periphery of the mill is provided with a series of quickly removable log washer type teeth arranged for angular adjustment on special bases to which the teeth are attached. The disintegration is effected by combined cutting and rolling action in water within the mill. It is said to have a much wider application than the conventional log washer, as it can handle material up to 12 in. or larger in size. The mill is arranged for variable speed and variable pulp level. The combination of angular adjustment of blades, with variable depth of pulp and speed, provides unusual flexibility. It has a wide range of adaptability both for the treatment of ores and aggregates in a variety of industrial applications.

Motor Drive for Ball Mills

For pebble, ball, and tube mills, tumbling barrels, rotary mixers, and similar equipment, the Patterson Foundry & Machine Company, of East Liverpool, Ohio, has just placed a new motor on the market. This new drive is of the built-in motor type with helical gears in the reducing unit. It has a magnetic brake built into it, so that when the stop button is pushed the mill or cylinder stops immediately, and by pressing the inching button the mill can be inched over into exact position for discharging and for reloading. The drive is built in all sizes from 1 to 100 hp.

White-Hot Pliers

A novel portable electric tool has been introduced by the Ideal Commutator Dresser Company, 1958 Park Ave., Sycamore, Ill., in the so-called Ideal Thermo-Grip pliers which takes the place of an open-flame blow torch or burner. There are no tanks, gas lines, or other excess equipment. When the wire connections are plugged into any 110-volt a.c. lighting circuit, current passes through the transformer and instantly heats the jaws to a white-hot temperature.

This tool has numerous applications for soldering and heating work (which otherwise requires a blow torch with open flame), such as applying or removing solder slugs, work on soldered wire connections, stator connections in motors, and the like. Work can be held and heated while being soldered. Due to its compact design, the tool can be used in cramped quarters where it would be impossible to use wrenches and fittings. The complete unit weighs 14 lb.

Nickel's New Hoist

Canadian Allis-Chalmers, Ltd., is building at its plant at Rockfield, Que., what is said to be the largest mine hoist ever assembled, according to the International Nickel Company's *Nickel Cast Iron News*. The hoist is designed for use at the Creighton mine of the Nickel Company, and weighs over 1,500,000 lb. By way of comparison, it is stated that the largest hoists now in use in Canadian mining operations have 12- to 14-ft.-maximum-diameter drums, whereas the two conical drums on the Copper Cliff hoist are 25 ft. in diameter at the largest section, tapering down to 12 ft. The drums operate in conjunction, one hoisting and the other lowering.

These castings are made of a high-tensile iron of approximately the following composition: Total carbon, 2.70 to 3.00 per cent; manganese, 0.80 per cent; silicon, 1.75 per cent; and nickel, 1.25 to 1.50 per cent.

Typical test results on this material show: Tensile strength, 52,500 lb. sq. in.; transverse strength (12 in. between centers), 4,955 lb.; and Brinell hardness, 196 to 217.

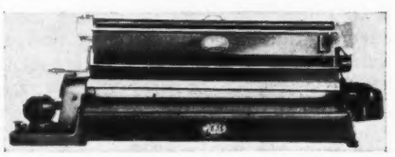
An interesting point in connection with the uniformity of the material is that the tensile and transverse strengths are found to be consistently in the ratio of around 10½ to 1. The hoist drums each weigh about 400 tons and are believed to be the largest castings ever made in Canada from alloyed iron.

Scout Core Drill

E. J. Longyear Company, Minneapolis, Minn., has introduced the Junior Scout core drill which is designed for sinking standpipe and core drilling after the ledge is reached. It will carry 3-in. casing through 100 ft. of overburden and has a rated capacity of 500 ft. of core, recovering core ⅞-in. in diameter. Although it is a new drill, the company states it has been given thorough tests in the field, with most satisfactory results. It is driven by a 10⅝-hp. gas engine. It is fully described in the company's new Bulletin No. 48.

Continuous Electric Printer

An entirely new combination printing-and-dry-developing machine for making white prints by the Ozalid process has been introduced by the Ozalid Corporation, 354 Fourth Ave., New York. It is the Wickes Simplex continuous electric printer. With



it can be made blueprints, Ozalid prints of various colors, and other direct process prints. It will print continuous rolls up to 44 in. in width and of unlimited length and separately cut sheets, either singly or in multiples by placing the tracings side by side. Printing speed can be varied from 24 in. down to a minimum satisfactory for slow-printing emulsions. The feed-driving motor takes 1.4 amp. at 110 volts. The lighting element is a mercury vapor tube. In dimension, the table-type Simplex is 21 in. deep, 11 in. high, and 69 in. wide.

Welding Comes Into Use For Crane Gears

The Harnischfeger Corporation of Milwaukee, builder of electric overhead traveling cranes, has recently developed a new means of fabricating gears through the use of welding with rolled steel. Lighter weight with greater resistance to wear and strain is claimed. Gears with helical or

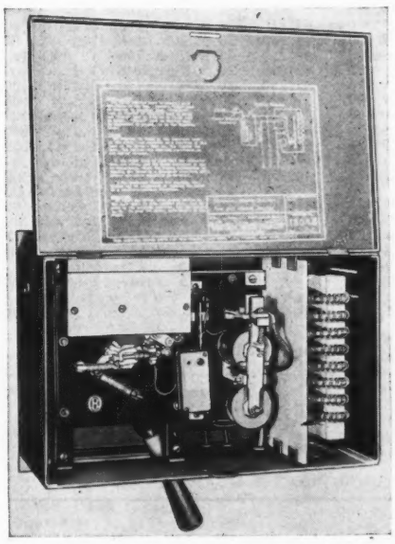
spur cut teeth are built up with arms and webbs of rolled steel, reinforced with gear bands welded integrally. The entire unit is normalized to provide the greatest possible strength. Through this type of construction, all danger of casting flaws is eliminated. In addition, there is the advantage of being able to select special steels for members which are subject to high stresses. Easier replacements are also possible.

Self-Curing Rubber Lining

A new refinement in its plastic rubber is announced by the Self-Vulcanizing Rubber Company, Inc., 605 West Washington Boulevard, Chicago, Ill. The shrinkage attendant upon its cold, self-curing process has been reduced to about one-third of that heretofore common in the application of rubber coatings and linings. Shrinkage of Selfvulc plastic will not now exceed 8½ per cent. This, it is claimed, means increased coverage and a thicker finished coating at no increased cost. It also means decreased internal strain in the rubber, and that means longer life.

Automatic D.C. Motor Starter

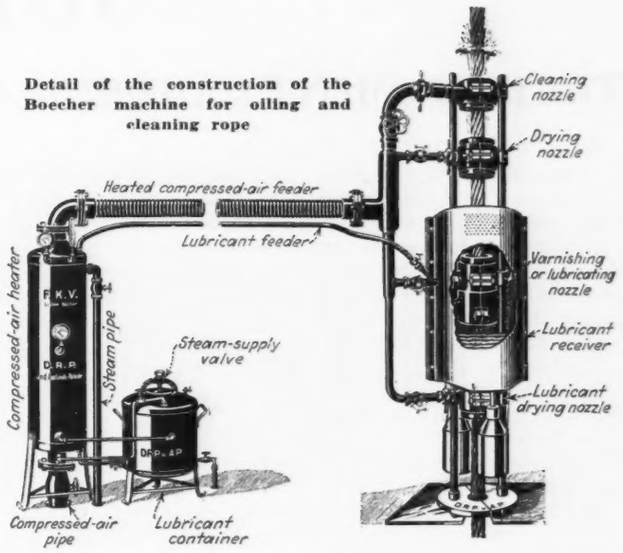
Further simplicity and larger clearances for the various parts have been secured in the Type DRT automatic d.c. motor starter, recently redesigned by the Ohio Brass Company, Mansfield, Ohio. This starter, one of five models offered by the company, was designed for automatically starting and protecting shunt- or compound-wound d.c. motors on conveyors, fans, pumps, and other mining machinery. It uses a relay-type starting mechanism, which starts the motor on resistance and throws it across the line when the speed has increased sufficiently. When power is resumed following an interruption or a severe voltage drop, the motor is restarted



automatically on resistance. Overload and short-circuit protection are provided by an automatic circuit breaker, fitted with a thermal element which is set for overloads of 25 per cent for three minutes. No fine adjustments of any parts are necessary. This starter is regularly furnished for 250- to 600-volt motors, ranging from 2 to 50 hp., but can be supplied in larger sizes.

Rope Oiler

Detail of the construction of the Boecher machine for oiling and cleaning rope



The Boecher machine for cleaning and lubricating hoisting rope, said to be used by over 150 mining operations in Europe, is now being offered by John J. Colombel, 200 Broadway, New York, as agent for Otto Adolphs, of Dortmund, Germany. With this equipment, the hoisting rope to be treated first passes through a nozzle, where it is thoroughly cleaned by a jet of heated compressed air. Another such compressed-air nozzle dries the rope in preparation of the subsequent lubricating process. The rope then passes through a lubricating or varnishing nozzle, where the lubricant or varnish is evenly applied by compressed air, also heated. Finally it passes through the drying nozzle to complete the treating operation.

To facilitate placing or removing the apparatus, provision is made for disassembling it into two parts by loosening a few setscrews. Treatment of a 2,500-ft. rope, it is stated, requires 25 to 30 minutes; assembling and dismantling the apparatus requires approximately an hour. Advantages cited for the apparatus include: elimination of brushes or scrapers, with decreased rope wear; grease or lacquer is applied to a previously cleansed and dried rope, with even distribution of lubricant or lacquer, assuring lasting preservation of the rope; thorough penetration of lubricant and immediate drying of lacquer, regardless of weather conditions; reduced cost; and greater safety of operations. This equipment is said to give efficient service.

INDUSTRIAL NOTES

The Great Lakes Exposition to be held along Cleveland's lake front starts on June 27 and continues to Oct. 4. The purpose of the exposition is to emphasize the importance of the Great Lakes region, but concerns in other industrial centers of the United States have made reservations for space at the exposition. An educational feature, "The Romance of Iron and Steel," will depict the story of iron from prehistoric time to the present. A historical drama of transportation in the Great Lakes will also be presented.

Tranter Manufacturing Company, of 105 Water St., Pittsburgh, Pa., announces that E. H. Jessop, formerly with Morse Chain Company, at Ithaca, N. Y., is now in charge of the company's Morse Chain sales. A complete stock of Morse industrial products is carried by Tranter in Pittsburgh, and the company's customers in this territory will now have in addition the services of a Morse factory-trained man.

Standard Oil Company of Indiana is producing a new series of oils under the name of "Stanoil," that will gradually replace many of the company's present brands. The object has been to produce an oil in six grades that so combine important characteristics that they will simplify lubrication practice.

Broderick and Bascom Rope Company, St. Louis, Mo., celebrated its 60th anniversary last month. The company's house organ, "The Yellow Strand," for May, featured among other items a recipe entitled "How To Be Youthful at 60." The Company was the pioneer rope manufacturer of the Middle West and Pacific Northwest, and "The Yellow Strand" was the first house organ published by any rope manufacturer in the United States. It has been issued continuously since 1904.

Morse Chain Company, Ithaca, N. Y., announces that George E. Olmstead, of New Haven, who has been operating as a manufacturer's agent in Connecticut, has joined the company's staff in the New York office. He will continue to cover the State of Connecticut, being located in New Haven.

James M. Degnan has been appointed general sales manager of the Hill Diesel Engine Company, Lansing, Mich., according to an announcement by James R. Tranter, president of the company.

SUMMARY OF

MONTHLY COMMENT . . . DAILY AND AVERAGE MONTHLY

WITH industrial activity during May at a higher level than in the four preceding months of the year, the movement of major non-ferrous metals into consumption in this country continued at a rate sufficiently large to support prices, even though buying was on a reduced scale. In copper, because of the heavy bookings in April, a dull period was fully anticipated; but producers were prepared for a livelier trade in both lead and zinc.

Our index number of non-ferrous metal prices for May was 72.51, which compares with 72.27 in April and 72.25 in January. The moderate advance for May resulted chiefly from a higher monthly average in copper.

Statistically, the important metals have shown comparatively little change since the first of the year, at least so far as this country is concerned, indicating that production and consumption are about in balance. Stocks of copper, lead, and zinc in the United States at the beginning of each of the last five months, in short tons, were as follows:

	Copper	Lead	Zinc
January 1....	231,415	222,306	83,758
February 1...	232,865	224,013	79,207
March 1	230,292	225,010	75,517
April 1.....	238,601	223,388	79,841
May 1.....	233,824	220,991	80,782

Domestic sales of copper during May totaled 16,303 tons, which compares with 158,064 tons in April. All of the business was booked on the basis of 9½c., Valley. Apparent consumption of copper in this country in April was 59,704 tons, according to the Copper Institute, with preliminary estimates on the use of the metal in May somewhat higher. The foreign market for copper was unsettled, largely because of adverse political developments on the Continent.

Shipments of lead to domestic consumers in April totaled 40,457 tons, against 36,743 tons in March. Buying was fair, showing general improvement toward the end of the month. The quotation held on the basis of 4.60c., New York, with the undertone firm.

Continued unsettlement in the London zinc market restricted business.

The International Tin Committee postponed taking action on third-quarter production quotas, evidently believing that Bolivia will increase output appreciably. The London market was weak.

Silver in the open market fell back to 44¾c. after a moderate flurry over the Chinese-American monetary agreement.

United States Market

1936 May	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	9.275	8.850	47.000	4.60	4.45	4.90
2	9.275	8.850	47.000	4.60	4.45	4.90
4	9.275	8.875	46.875	4.60	4.45	4.90
5	9.275	8.875	46.875	4.60	4.45	4.90
6	9.275	8.900	46.700	4.60	4.45	4.90
7	9.275	8.875	46.625	4.60	4.45	4.90
8	9.275	8.850	46.650	4.60	4.45	4.90
9	9.275	8.850	46.650	4.60	4.45	4.90
11	9.275	8.850	46.700	4.60	4.45	4.90
12	9.275	8.850	46.900	4.60	4.45	4.90
13	9.275	8.825	46.900	4.60	4.45	4.90
14	9.275	8.800	46.875	4.60	4.45	4.90
15	9.275	8.825	46.875	4.60	4.45	4.90
16	9.275	8.825	46.875	4.60	4.45	4.90
18	9.275	8.800	46.375	4.60	4.45	4.90
19	9.275	8.800	45.900	4.60	4.45	4.90
20	9.275	8.800	45.750	4.60	4.45	4.90
21	9.275	8.800	45.875	4.60	4.45	4.90
22	9.275	8.775	45.825	4.60	4.45	4.90
23	9.275	8.750	45.825	4.60	4.45	4.90
25	9.275	8.725	45.750	4.60	4.45	4.90
26	9.275	8.750	45.875	4.60	4.45	4.90
27	9.275	8.825	46.000	4.60	4.45	4.90
28	9.275	8.775	45.250	4.60	4.45	4.90
29	9.275	8.800	44.875	4.60	4.45	4.90
30	Holiday	8.800	Holiday			
Av. for month	9.275	8.819	46.352	4.60	4.45	4.90
Averages for Week						
6	9.275	8.863	46.846	4.60	4.45	4.90
13	9.275	8.850	46.738	4.60	4.45	4.90
20	9.275	8.808	46.442	4.60	4.45	4.90
27	9.275	8.771	45.858	4.60	4.45	4.90
Calendar Week Averages						
2	9.275	8.871	46.779	4.60	4.45	4.90
9	9.275	8.871	46.729	4.60	4.45	4.90
16	9.275	8.829	46.854	4.60	4.45	4.90
23	9.275	8.788	45.925	4.60	4.45	4.90
30	9.275	8.779	45.550	4.60	4.45	4.90

Silver, Gold, and Sterling Exchange New York and London

1936 May	Sterling Exchange "Checks"	Sterling Exchange "90-day" Demand	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	4.93750	4.93250	44.750	20.3125	140s 10 d	$35.00
2	4.93875	4.93375	(e)	20.2500	140s 10 d	35.00
4	4.95875	4.95375	44.750	20.3750	140s 4 d	35.00
5	4.96250	4.95625	44.750	20.3125	140s 4½d	35.00
6	4.95500	4.94875	44.750	20.2500	140s 8 d	35.00
7	4.97000	4.96250	44.750	20.2500	140s 8½d	35.00
8	4.97500	4.96625	44.750	20.2500	140s 5½d	35.00
9	4.98250	4.97375	(e)	20.1250	140s 2½d	35.00
11	4.96375	4.95500	44.750	20.3750	140s 6 d	35.00
12	4.97375	4.96500	44.750	20.3750	140s 2½d	35.00
13	4.97000	4.96250	44.750	20.4375	140s	35.00
14	4.95750	4.94875	45.250	20.5625	140s 3 d	35.00
15	4.96250	4.95375	45.750	20.8750	140s 2 d	35.00
16	4.96375	4.95500	(e)	20.6250	140s 3 d	35.00
18	4.96750	4.96000	45.375	20.5625	140s 1 d	35.00
19	4.96750	4.95875	45.125	20.5000	139s 11 d	35.00
20	4.97000	4.96125	44.750	20.3125	139s 11½d	35.00
21	4.96750	4.95875	44.750	20.0625	139s 11½d	35.00
22	4.97250	4.96375	44.750	20.0000	139s 11½d	35.00
23	4.97625	4.96750	(e)	20.0625	139s 8 d	35.00
25	4.97875	4.97125	44.750	20.0625	139s 7 d	35.00
26	4.97875	4.97125	44.750	20.0000	139s 8 d	35.00
27	4.98000	4.97125	44.750	19.7500	139s 7½d	35.00
28	4.99000	4.98125	44.750	19.9375	139s 6 d	35.00
29	4.99250	4.98500	44.750	19.8750	139s 3½d	35.00
30	Holiday			19.9375	139s 3 d	Holiday
Av. for month	4.96850	.....	44.869	20.248	.....	35.00
Averages for Week						
6	4.94833	.....	44.750	.....	.....	.....
13	4.97250	.....	44.750	.....	.....	.....
20	4.96479	.....	45.250	.....	.....	.....
27	4.97563	.....	44.750	.....	.....	.....

Calendar week averages: New York Silver, May 2nd, 44.750; 9th, 44.750; 16th, 45.050; 23rd, 44.950; 30th, 44.750.

(e) No quotation.

The above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

THE MARKETS

PRICES OF METALS . . . MISCELLANEOUS QUOTATIONS

London Market

1936 May	Copper Standard Spot	Copper Standard 3M	Copper Electrolitic Bid	Tin Standard Spot	Tin Standard 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
1	37.1250	37.4375	41.2500	207.7500	202.2500	16.0000	16.0625	14.7500	15.0000
4	37.0625	37.3750	41.3750	207.0000	200.7500	15.8750	15.9375	14.8125	15.0625
5	37.0000	37.3125	41.3750	205.2500	199.7500	15.9375	15.9375	14.8750	15.1250
6	37.0000	37.3125	41.3750	205.0000	199.7500	15.8750	15.8750	14.8750	15.1250
7	36.9375	37.2500	41.2500	204.2500	198.5000	15.6875	15.6875	14.8125	15.0625
8	36.6875	36.9375	40.7500	203.5000	197.5000	15.3750	15.4375	14.5625	14.8125
11	36.8750	37.1875	41.0000	204.0000	197.7500	15.3750	15.4375	14.5000	14.7500
12	36.7500	37.0625	41.0000	204.0000	197.5000	15.2500	15.3125	14.6250	14.8750
13	36.5625	36.8125	40.7500	203.7500	197.8750	15.1250	15.1875	14.3750	14.5625
14	36.6875	37.0000	40.7500	204.5000	198.5000	15.4375	15.5625	14.5000	14.7500
15	36.8125	37.1250	41.0000	205.3750	199.3750	15.5000	15.5625	14.8125	15.0000
18	36.6250	36.9375	40.7500	202.7500	197.7500	15.5000	15.5625	14.6875	14.8750
19	36.5625	36.8750	40.7500	200.2500	195.5000	15.5000	15.5625	14.5000	14.6875
20	36.2500	36.5625	40.5000	198.2500	193.7500	15.3750	15.5000	14.3750	14.6250
21	36.4375	36.6875	40.5000	199.5000	194.7500	15.3125	15.5000	14.3125	14.6250
22	36.1250	36.4375	40.2500	199.7500	194.0000	15.4375	15.6250	14.1875	14.5000
25	36.4375	36.6875	40.2500	200.0000	195.2500	15.3750	15.5000	14.2500	14.5625
26	36.8750	37.1250	41.0000	201.2500	196.2500	15.6250	15.6875	14.3750	14.6875
27	36.6250	36.8750	40.7500	201.0000	196.2500	15.5625	15.6250	14.4375	14.6250
28	36.5000	36.7500	40.5000	198.2500	193.8750	15.4375	15.5000	14.3750	14.5625
29	36.5625	36.8125	40.5000	195.6250	191.5000	15.5625	15.5625	14.2500	14.4375
Av. for month	36.690	.....	40.839	202.429	.....	15.530	15.601	14.536	14.777

Current Prices—Miscellaneous Metals, Ores, and Non-Metallic Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated.

(June 1, 1936)

Miscellaneous Metals

Aluminum, ingot, 99 plus per cent, lb.	19@21c.
Antimony, domestic spot, lb.	12.250
Bismuth, ton lots, lb.	$1.00
Cadmium, lb.	$1.05
Chromium, 97 per cent grade, lb.	85c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (official quotation) troy oz.	$35.00
Quicksilver, flask of 76 lb., 100 flasks or more	$74.50
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent. spot, lb.	16.50c.
Tellurium, lb.	$1.75@$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

Metallic Ores

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f., long ton	$16.00@$16.50
Iron Ore, Lake Superior, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent Joplin, Mo., ton	$49.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent.	26c.
49@51 per cent.	26c.
44@47 per cent.	25c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$15.75
Domestic Scheelite	$15.75
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$32.00

Metallic Compounds

Arsenious Oxide (arsenic) lb.	3½c.
Cobalt Oxide, 70@71 per cent, lb.	$1.41@$1.51
Copper Sulphate, 100 lb.	$4.00
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb.	$1.29
Sodium Sulphate, bulk, ton.	$13.00@$15.00

Alloys

Beryllium-Copper, Master alloy 2.5 to 3 per cent Be, per lb. of contained Be	$30.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb.	10c.
Ferromanganese, 78@82 per cent, gross ton	$75.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained.	95c.
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75@80 per cent, lb. of W contained	$1.30@$1.40

Non-Metallic Minerals

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@.....
Crude No. 2	$200@$225
Spinning fibers	$90@$150
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50.....
Paper stock	$35@.....
Cement stock	$23@.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a) $5.50@ $7.00
French, 56@59 per cent	(a) $6.50@ $7.50
China Clay, f.o.b. mines ton:	
South Carolina and Georgia, bulk	$7.00@ $9.00
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@....
Dead-burned, f.o.b. Washington	$22.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½x2 in.	15@30c.
2x2 in.	30@50c.
3x3 in.	75@ $1.00
3x4 in.	$1.00@$1.25
4x6 in.	$2.00@ $2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12@ 12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@....

(a) Nominal.

Iron and Steel

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$20.00
Basic	$19.00
No. 2 Foundry	$19.50
Steel, base prices, Pittsburgh:	
Billets, gross ton	$28.00
Structural shapes, 100 lb.	$1.80
Bars, 100 lb.	$1.85

MONTHLY AND YEARLY AVERAGE PRICES

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1935	1936	1935	1936	1935	1936
January	54.418	47.250	24.584	20.250	489.207	496.115
February	54.602	44.750	24.818	19.796	487.278	499.908
March	59.048	44.750	27.380	19.663	477.635	496.952
April	67.788	44.892	30.986	20.245	483.596	494.139
May	74.356	44.869	33.865	20.248	488.587	496.850
June	71.940	.....	32.346	.....	493.245	.....
July	68.216	.....	30.500	.....	495.558	.....
August	66.366	.....	29.476	.....	496.815	.....
September	65.375	.....	29.255	.....	492.917	.....
October	65.375	.....	29.368	.....	490.577	.....
November	65.375	.....	29.284	.....	492.277	.....
December	58.420	.....	25.563	.....	492.715	.....
Year	64.273	.....	28.952	.....	490.034	.....

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery, Electrolytic, Domestic		F.O.B. Refinery, Electrolytic, Export		London Spot, Standard		London Spot, (a) Electrolytic	
	1935	1936	1935	1936	1935	1936	1935	1936
January	8.775	9.025	6.583	8.358	28.077	34.706	31.261	38.788
February	8.775	9.025	6.341	8.566	27.175	35.313	30.244	39.463
March	8.775	9.025	6.526	8.708	28.518	36.040	31.607	40.227
April	8.775	9.169	7.328	8.849	31.231	36.975	34.763	41.131
May	8.775	9.275	7.794	8.819	33.344	36.690	36.733	40.839
June	8.634	.....	7.307	.....	30.799	.....	34.039	.....
July	7.775	.....	7.350	.....	31.024	.....	34.261	.....
August	7.979	.....	7.738	.....	32.646	.....	35.976	.....
September	8.504	.....	8.146	.....	34.036	.....	37.952	.....
October	8.967	.....	8.514	.....	35.226	.....	39.609	.....
November	9.025	.....	8.414	.....	35.229	.....	39.396	.....
December	9.025	.....	8.414	.....	35.097	.....	39.313	.....
Year	8.649	.....	7.538	.....	31.867	.....	35.430	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotation.

Lead

	New York		St. Louis		London			
	1935	1936	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos.
January	3.692	4.500	3.542	4.350	10.321	10.514	15.397	15.494
February	3.528	4.515	3.378	4.365	10.216	10.413	16.022	16.141
March	3.579	4.600	3.429	4.450	11.012	11.188	16.608	16.767
April	3.692	4.600	3.542	4.450	12.231	12.459	16.097	16.234
May	3.962	4.600	3.812	4.450	13.861	13.940	15.530	15.601
June	4.020	.....	3.870	.....	13.776	13.806	.....	.....
July	4.123	.....	3.973	.....	14.451	14.511	.....	.....
August	4.254	.....	4.104	.....	15.774	15.792	.....	.....
September	4.413	.....	4.263	.....	16.262	16.315	.....	.....
October	4.512	.....	4.362	.....	18.209	18.209	.....	.....
November	4.500	.....	4.350	.....	17.938	17.935	.....	.....
December	4.500	.....	4.350	.....	16.803	16.828	.....	.....
Year	4.065	.....	3.915	.....	14.238	14.326	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

Tin

	Straits New York		Standard, Spot London	
	1935	1936	1935	1936
January	50.916	47.234	231.193	209.731
February	50.063	47.962	227.381	207.081
March	46.962	48.037	215.726	213.080
April	50.154	46.963	223.513	209.313
May	51.138	46.352	227.602	202.429
June	51.108	.....	227.586	.....
July	52.297	.....	232.397	.....
August	50.463	.....	222.935	.....
September	49.126	.....	223.929	.....
October	51.160	.....	226.891	.....
November	51.864	.....	226.452	.....
December	49.794	.....	220.075	.....
Year	50.420	.....	225.473	.....

New York quotations, cents per pound. London, pounds sterling per long ton

Zinc

	St. Louis		London			
	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos.
January	3.730	4.848	11.994	12.207	14.488	14.719
February	3.714	4.859	11.819	12.000	15.125	15.391
March	3.894	4.900	12.095	12.250	15.983	16.190
April	4.030	4.900	12.891	13.128	15.181	15.334
May	4.220	4.900	14.534	14.685	14.536	14.777
June	4.299	.....	13.734	13.898	.....	.....
July	4.325	.....	14.065	14.185	.....	.....
August	4.535	.....	14.714	14.938	.....	.....
September	4.669	.....	15.414	15.616	.....	.....
October	4.825	.....	16.440	16.674	.....	.....
November	4.850	.....	16.193	16.372	.....	.....
December	4.850	.....	15.091	15.278	.....	.....
Year	4.328	.....	14.082	14.269	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1935	1936	1935	1936
January	55.000	105.000	20.000	20.000
February	55.000	105.000	20.000	20.000
March	58.462	105.000	20.000	20.000
April	65.000	105.000	20.000	20.000
May	65.000	105.000	20.000	20.000
June	65.000	.....	20.000	.....
July	65.000	.....	20.000	.....
August	70.000	.....	20.000	.....
September	75.625	.....	20.000	.....
October	85.000	.....	20.000	.....
November	85.000	.....	20.000	.....
December	101.800	.....	20.000	.....
Year	70.491	.....	20.000	.....

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1935	1936	1935	1936	1935	1936
January	14.111	12.736	72.760	76.769	34.000	36.885
February	14.250	12.967	72.500	77.000	34.000	35.000
March	14.250	13.072	72.500	77.000	32.846	34.115
April	14.029	12.673	72.500	76.731	32.000	32.846
May	12.712	12.410	72.135	74.940	32.000	32.000
June	12.500	.....	71.460	.....	32.000	.....
July	12.500	.....	70.538	.....	32.000	.....
August	12.500	.....	69.000	.....	31.333	.....
September	13.177	.....	69.208	.....	36.000	.....
October	15.322	.....	71.750	.....	37.615	.....
November	14.217	.....	74.348	.....	38.000	.....
December	13.820	.....	75.200	.....	38.000	.....
Year	13.616	.....	71.992	.....	34.150	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1935	1936	1935	1936	1935	1936
January	19.00	20.00	18.00	19.00	18.50	19.50
February	19.00	20.00	18.00	19.00	18.50	19.50
March	19.00	20.00	18.00	19.00	18.50	19.50
April	19.00	20.00	18.00	19.00	18.50	19.50
May	19.00	20.00	18.00	19.00	18.50	19.50
June	19.00	.....	18.00	.....	18.50	.....
July	19.00	.....	18.00	.....	18.50	.....
August	19.00	.....	18.00	.....	18.50	.....
September	19.00	.....	18.00	.....	18.50	.....
October	19.00	.....	18.00	.....	18.50	.....
November	20.00	.....	19.00	.....	19.50	.....
December	20.00	.....	19.00	.....	19.50	.....
Year	19.167	.....	18.167	.....	18.667	.....

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces.